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REPORT OF THE TASK FORCE FOR
IMPROVED COORDINATION OF THE DoD SCIENCE
AND TECHNOLOGY PROGRAM

Volume II: Reports of the Working Groups

Working Group A: Strategic Planning

Working Group B: Program Coordination

Working Group C: Advocacy

Editors:

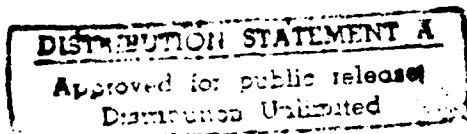
Frederick R. Riddell

David A. Dierolf

Paul H. Richanbach

Karen J. Richter

August 1988



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19. ABSTRACT (Continue on reverse if necessary and identify by block number) In November 1987 the Deputy Under Secretary of Defense, Research and Advance Technology, instructed the Institute for Defense Analyses (IDA) to assemble a Task Force, drawn largely from the community that carries out the Department of Defense's Science and Technology (S&T) program. This Task Force was chartered to "develop a strategy and an implementation plan for improving the coordination of resources and responsibilities among the DoD laboratories with an emphasis on strategic planning." The Task Force was formed and held an intensive series of meetings from January to July 1988, culminating in this report. Over 50 people were involved in the Task Force and its working groups, representing a cross section of senior personnel from all the DoD components responsible for science and technology, as well as representatives from the private sector. Volume I of the report details the findings of the Task Force and its recommendations to the Director of Defense Research and Engineering. These recommendations are presented in terms of a strategy and a plan for improving the overall coordination, responsiveness, and efficiency of the Science and Technology program. Volume II of the report contains the reports of the Task Force's three working groups.				
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PREFACE

This document was prepared by a Task Force assembled by the Institute for Defense Analyses for the Deputy Under Secretary of Defense for Research and Advanced Technology under Contract No. MDA 903 84 C 0031, Task T-D6-563, *Task Force on Increased Coordination of Service Laboratory Activities*. The document, edited by IDA personnel, records the deliberations of the Task Force and presents its findings and recommendations; Volume I contains the summary and recommendations, and Volume II consists of the reports of the working groups. The recommendations presented here represent the consensus view of the group, which was selected to represent a cross section of the community that must implement the recommendations. It was understood throughout the evolution of this report that dissenting views would be accepted and included in the report, but none have been presented.

This document was reviewed by R.Adm. Leland S. Kollmorgen, USN (Ret.), Gen. Robert T. Marsh, USAF (Ret.), and Lt. Gen. Robert L. Moore, USA (Ret.) as a group, and also by Mr. Seymour J. Deitchman, IDA consultant. The review group included the following comment in its review:

We believe the recommendations and accompanying action plans are stated in clear and understandable terms for ease of implementation. We believe that the underlying rationale and reasons for the conclusions and recommendations are clearly stated and adequately supported with one possible exception. The report concludes that the DoD S&T program deserves increased funding support in view of the nation's dwindling technological lead and our increased dependence upon such leadership to support our national security policy. This issue begs the question of how much funding is enough in light of other priorities--a question which does not lend itself to straightforward analysis and on which well informed people differ. It is understandable that a study group comprised of key managers of the S&T program would be biased in favor of increased support of their programs. The report reflects their unanimous belief that increased funding support is needed.

ACKNOWLEDGMENTS

Over 50 people having various associations with the DoD Science and Technology Program contributed to this report by serving on the Core Group and the three working groups that made up the Task Force. The work involved for each individual was significant--involving attendance at monthly two-day meetings over five months for the working groups and over seven months for the Core Group. In addition, work was required to prepare for the meetings and review the results as the reports were developed. In total, the Task Force members donated many thousands of man-hours to reaching the findings and recommendations contained in this report.

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GLOSSARY

A. GENERAL TERMINOLOGY

Many of the terms used to describe "coordination" and "planning" processes for science and technology programs are subject to multiple interpretations. The Task Force adopted the following definitions:

S&T	Science and Technology. The Science and Technology Program consists of the programs in budget categories 6.1 (Research), 6.2 (Exploratory Development), and 6.3A (Advanced Technology Development). This report avoids the use of the term Technology Base, which is often used to refer only to the 6.1 and 6.2 budget categories, but sometimes includes 6.3A.
S&T Strategic Planning	<i>A process of developing for the S&T program a strategy and an implementation plan for achieving an agreed-upon set of long range objectives.</i>
S&T Investment Strategy	An S&T Investment Strategy establishes technology goals to meet stated objectives and shows the resources that are being applied to reach those objectives. It is the documentation resulting from the strategic planning process
S&T Program Coordination	The process of compiling milestone and resource information on program content and formulation by S&T technology areas across all DoD Services and Agencies (such compilations are sometimes called "Technology Roadmaps").
Technical Coordination	The exchange of technical information, often at the working ("bench") level.
Roadmaps	See "S&T Program Coordination."

B. ACRONYMS

ASBREM	Armed Services Biomedical Research Evaluation and Management Committee
ATTD	Advanced Technology Transition Demonstration
BTI	Balanced Technology Initiative
C3I	Command, Control, Communications, and Intelligence
CBW	Chemical Biological Warfare
CDI	Conventional Defense Initiative
CINC	Commander in Chief
CW/CBD	Chemical Warfare/Chemical Biological Defense
DAB	Defense Acquisition Board
DARPA	Defense Advanced Research Projects Agency
DIA	Defense Intelligence Agency
DDR&E	Director, Defense Research and Engineering
DNA	Defense Nuclear Agency
DSB	Defense Science Board
DUSD/R&AT	Deputy Under Secretary of Defense, Research and Advanced Technology
EMP/EMI	Electromagnetic Pulse/Electromagnetic Interference
EW	Electronic Warfare
FFRDC	Federally Funded Research and Development Center
FSED	Full Scale Engineering Development
FYDP	Five-Year Defense Plan
IR&D	Independent Research and Development
JDL	Joint Directors of Laboratories
JLC	Joint Logistics Commanders
JSCERDCG	Joint Services Civil Engineering Research and Development Coordinating Group
JSRG-CW/CBD-RDA	Joint Services Review Group - Chemical Warfare and Chemical-Biological Defense - Research, Development and Acquisition
MCP	Military Construction Programs

NASA	National Aeronautics and Space Administration
NSF	National Science Foundation
OSD	Office of the Secretary of Defense
OTA	Office of Technology Assessment
POM	Program Objectives Memorandum
PPBS	Planning, Programming, and Budgeting System
R&AT	Research and Advanced Technology
R&D	Research and Development
RDA	Research, Development and Acquisition
RDT&E	Research, Development, Test, and Engineering
SDI	Strategic Defense Initiative
SECDEF	Secretary of Defense
SPO	System Program Office
TCG	Technology Coordinating Group
TCP	Technology Coordinating Panel
TD	Technical Director
TOA	Total Obligational Authority
USD(A)	Under Secretary of Defense (Acquisition)

Section I

WORKING GROUP A, STRATEGIC PLANNING

WORKING GROUP A, STRATEGIC PLANNING

A. INTRODUCTION

1. Background

The Task Force for Improved Coordination of DoD Science and Technology Programs was formed in order to develop a strategy and implementation plan for improving the overall coordination of Science and Technology (S&T) Programs within the Department of Defense. There is currently no forum that provides a coordinated, overall picture of DoD technology efforts that supports a long-term coordinated military plan for the future protection of our country.

There is a need for a strong, focused, and coordinated S&T program to support our policy of reliance on superior technological capability in all aspects of our military forces. In an era when budgets are declining and our major adversary is closing the technology gap, it is of vital importance that our S&T resources be expended wisely. The objective of the Task Force is to recommend ways in which the allocation of resources to S&T programs can be made more effective.

2. Charter and Participants

To address this problem and develop a strategy and implementation plan for improving coordination of resources and responsibilities among DoD laboratories, the Core Group of this Task Force identified three major areas: (1) strategic planning, (2) coordination mechanisms, and (3) advocacy for S&T programs. Working Groups were chartered to address these areas. This report presents the findings and recommendation of Working Group A, which was chartered to address the strategic planning issues. The charter for Working Group A included the following objective:

To recommend ways in which strategic planning of Science and Technology (S&T) Programs can be improved and coordinated throughout DoD.

The working group was instructed to address, at a minimum, the following four issues:

1. What should be the OSD role in strategic S&T planning?
2. What should a Service strategic S&T plan contain (e.g., time horizon, level of detail)?
3. How should Service strategic S&T plans be coordinated?
4. How should the effectiveness of the strategic planning process be measured?

A complete list of members of Working Group A is given in Appendix A.

3. Activities

What follows is a brief chronological summary of Working Group A activities. The Working Group met five times between February and June 1988. The first meeting of Working Group A was spent exploring the assigned issues in detail. The group decomposed the issues further and agreed to write "white papers" on selected topics. At the second meeting, presentations were made by:

- Ray Siewert 1987 DSB Study on Tech Base Management
- Len Sullivan Goals for Long Range Planning of S&T Programs
- Alan Shaw OTA Study of the Defense Tech Base
- Henry Velkoff Army Rotocraft Program Strategic Planning Process

Following the presentations the group reviewed the homework assigned at the first meeting. Issues 1 and 2 were identified as the most important issues. Writing assignments were made so a draft report could be put together by the third meeting. The third meeting started with a presentation by Dr. Kristin Hessenius on strategic planning at NASA Ames Research Center. After a discussion of the presentation the group reviewed the first draft report and developed preliminary recommendations to be presented to the Core Group. At the fourth meeting the Working Group received feedback from the Core Group and heard about briefings given to R&AT and DDR&E. Small subgroups formed to address the remaining issues. The final meeting of Working Group A was spent on a detailed review of the Working Group recommendations. The detailed results of the group's deliberations are contained in the following sections.

B. FINDINGS

1. There Are Existing S&T Planning Processes

There is a significant amount of long-range planning currently going on within each of the Services (see Appendices B, C, and D). The lowest level at which this planning occurs usually includes two perspectives:

- (1) A five-year business plan
- (2) A 10-20 year strategic (corporate) plan.

The purpose of these plans has historically been to guide the investment of resources of centers within each Service. Recently the R&D centers, as well as the Services, have been developing S&T plans and strategies as integral parts of their business plans. These efforts are, at the moment, pursued independently within each of the Services and, to some degree, independently at the R&D center level.

2. Current Investment Strategy Reviews Do Not Provide Adequate Guidance

Typically, DUSD (R&AT) conducts an annual investment strategy review of each Service lasting 2-3 days. The appropriate Service Director of Laboratories provide an overview of the Service S&T Program followed by laboratory briefings which cover the following: mission statement; people and funding trends; facilities, including Military Construction Programs; selected major technology thrusts; accomplishments, transition effort, and new starts. Specific guidance is not provided for an investment strategy, but only for DUSD/R&AT reviews.

3. There Are Important Weaknesses in the Current Process

This process has several shortcomings. First, in the absence of specific planning guidance, it is difficult to assess, other than by technical merit, the individual Service investment strategies and their relation to overall DoD objectives. Since each Service is reviewed separately, their relationship to each other is also difficult to assess. Furthermore, other than the verbal comments received from R&AT during the actual review, no formal or written feedback is provided to the Services. Thus the investment strategy reviews primarily serve an information gathering function.

There is strong interaction at the programmatic level between the Services and the defense agencies such as DARPA, and technology base programs of these agencies are

generally complementary to Service programs. If, however, these agencies have their own investment strategies, it is not apparent to the Services. Although programs are coordinated at the working level, any high-level reviews seldom involve the Services. Considering the extent and impact of their programs, the investment strategies of other DoD agencies should be reviewed at the same level as the Service investment strategies, and should be factored into an overall DoD strategy. In the absence of such inputs and reviews OSD cannot perform a complete assessment of the objectives, priorities, and merit of the total DoD science and technology program.

4. There Is A Need For DoD-Wide Strategic Planning

A DoD-wide investment strategy is needed that would tie together the investment strategies as they currently exist in the Services and Agencies. Strategic planning must be seen as a necessary part of the S&T program execution. It involves establishing and keeping current (1) an S&T guidance document that sets forth near- and far-term operational objectives and (2) an investment strategy that establishes technology goals to meet these objectives. Strategic planning also involves getting feedback from the technology programming and resource allocation that is carried out to meet the technology goals. The feedback from these execution phases to the guidance and investment strategy is necessary to identify any disconnects that need remedial action either by modifying the strategy or changing priorities in the execution process. If the strategic planning process is to be effective, senior management must be actively involved.

C. POLICY RECOMMENDATIONS

The Secretary of Defense should reaffirm that a strong S&T program is essential to support our policy of maintaining technological superiority in our war-fighting capabilities. It is imperative that the S&T program be carefully focused on both near- and far-term needs so as to achieve the maximum returns on its investments. To this end, it is recommended that the Secretary of Defense establish a DoD-wide S&T strategic planning process under the direction of USD(A) and DDR&E. The following specific actions need to be taken:

1. DoD S&T Guidance

USD(A) should initiate and lead a participative and iterative process, executed by DDR&E, to produce DoD S&T Guidance. The participants in this process must include the appropriate S&T Program Secretariats of the Services, the Directors of the S&T activities from the Services and other DoD agencies, representatives from the JCS, and

representatives from the Intelligence communities. The centerpiece of this process will be a document which should be used to formulate the S&T portion of the Defense Guidance and is also used by the Services and Agencies to guide the development of their Investment Strategies.

The DoD S&T Guidance should be developed from:

- the projected threat
- military/defense strategy
- operational needs and utility
- technological opportunities
- high level guidance (e.g., the President, Congress, Secretary of Defense)
- the non-DoD sector (e.g., industry, academia, foreign)
- prior year DoD S&T Guidance, investment strategies and programmatic assessments.

2. Service/Agency Investment Strategies

USD(A) should direct the DoD Services and Agencies conducting S&T programs to develop S&T Investment Strategies guided by and consistent with the DoD S&T Guidance and submit them for review.

These strategies should contain discussions of the following areas showing the current and planned resources being applied to meet the objectives set forth in the DoD S&T Guidance.

- existing and projected war-fighting environment
- operational capabilities
- broad system concepts
- key technology goals.

3. Investment Strategy Reviews

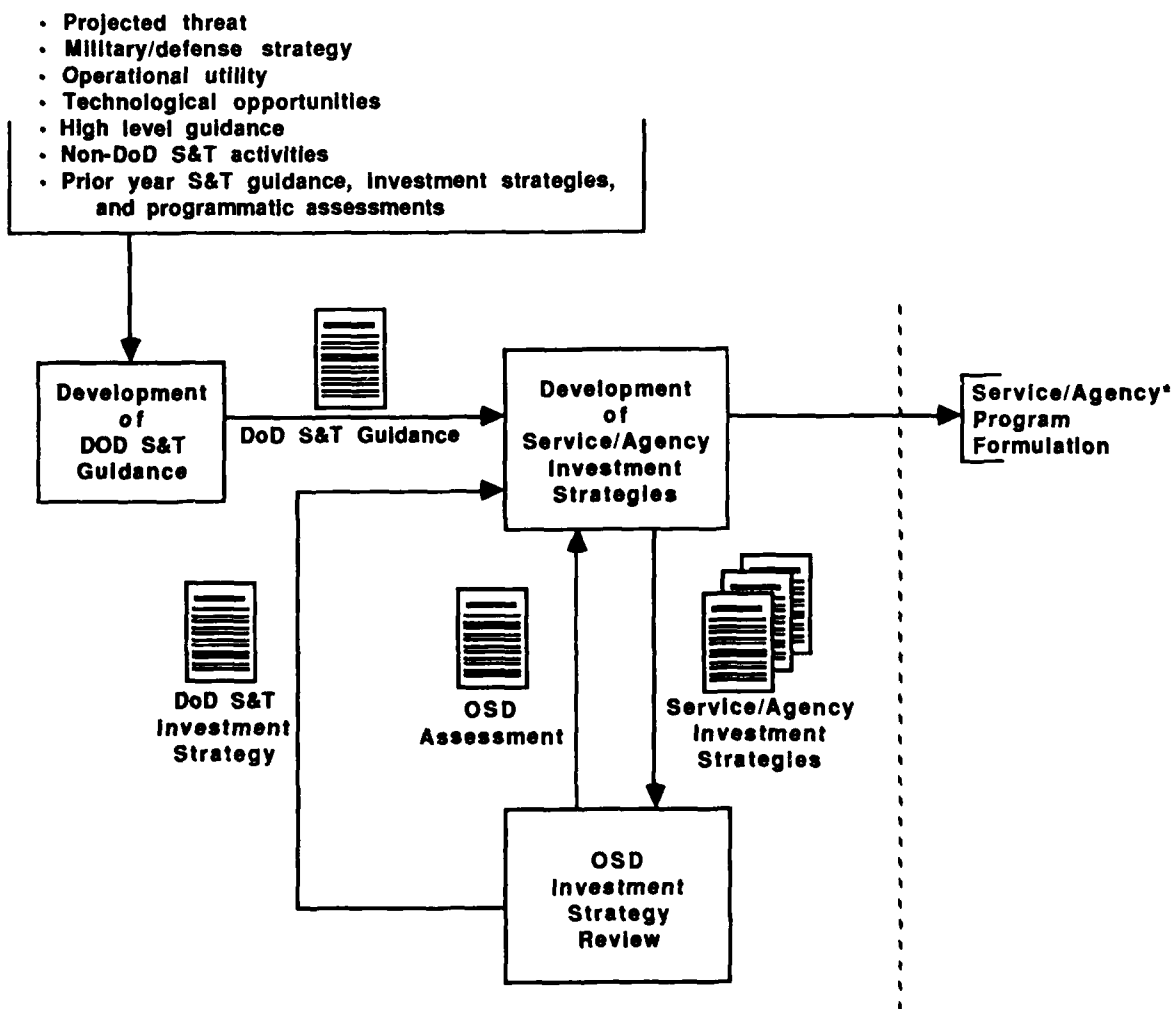
USD(A) and the other participants in the formulation of the DoD S&T Guidance should review Service/Agency investment strategies to ensure that they:

- are consistent with the DoD S&T Guidance;
- are coordinated across other Services and agencies, resolving conflicts and assigning leadership responsibilities;

- identify missing elements in the technology goals compared to the operational objectives; and
- set priorities and resource allocations with respect to technology goals, the industrial technology base, and support to academia.

The result of this process will be a document containing the DoD S&T Guidance, the Service/Agency Investment Strategies and a summary chapter of the consolidated DoD investment strategy. This document will be referred to as the DoD S&T Investment Strategy.

An overview of the proposed process appears in Figure I-1.



*See Section II, Working Group B, for Program Coordination details.

Figure I-1. Process to Develop a Coordinated DoD S&T Investment Strategy

D. IMPLEMENTATION PLAN

1. The DoD S&T Guidance

S&T guidance must be responsive to existing and projected threats, result in improved war fighting capabilities, and provide a long-term (10-20 year) view. Part of the guidance will be specific development goals which will assure the availability of mature technologies to meet future threats and support national objectives. Specific 10-20 year development goals will focus numerous S&T efforts and spawn new ones to fill gaps in the S&T program. Some example objectives are:

- a. A real-time global capability to detect, track, and identify low observables.
- b. Survivable, adaptive communication capability.
- c. Rapid, worldwide deployment of forces within hours.

Such broad requirements should provide sufficient direction for the Services and other DoD agencies to develop the technology goals for new or improved sensors, weapons, platforms, etc., along with supporting technologies in electronics, materials, propulsion, structures, etc. Clearly, both near- and long-term goals for S&T must be driven by the need to respond to existing and projected threats. The long-term goals should challenge the S&T community to be innovative in providing new war-fighting capabilities that can impact national security objectives expressed in the DoD S&T Guidance.

In establishing this guidance, OSD must base it upon inputs from the technologists (S&T Programs), the operators (JCS), and the intelligence community. Only through dialogue between these communities can there be a realistic identification of existing and projected threats and a clear definition of promising technologies and serious military shortfalls.

The DoD S&T Guidance should be developed from (1) the projected threat (military planners); (2) military/defense strategy (the JCS); (3) operational utility (CINCs); (4) technological opportunities (technologists); (5) high level guidance (the President, Congress, Secretary of Defense); (6) the non-DoD sector (e.g., industry, academia, etc.); and (7) prior year DoD S&T guidance, investment strategies, and programmatic assessments. The guidance should focus on three distinct time frames:

- Near Term - current system upgrades;
- Mid Term - next generation systems; and
- Far Term - notional systems/new concepts.

The near- and mid-term time frames will provide for the exploitation of current and the pervasive technologies while the far term primarily provides for technology push. Together, an emphasis on all the three time frames will help to prevent technological surprise and provide a more structured framework for the transition of technology to operational systems.

The DoD S&T Guidance should contain treatments of the following subjects:

1. Projected External Environment
 - geopolitical, economic, technological environments
 - projected threat
 - strategy modifications
 - manufacturing and technology base.
2. Operational Considerations
 - future war fighting environment
 - mission requirement changes.
3. Required Military Capabilities
 - near term - provide technology for readiness and to fix deficiencies
 - mid term - provide technology to improved effectiveness (e.g., performance, cost, supportability)
 - far term - provide technology for new war fighting capabilities
 - Service unique capabilities (where appropriate).
4. National Level Thrusts
 - technology initiatives
 - inter-departmental coordination.

The DoD S&T Guidance should be developed by a group chaired by the DUSD/R&AT (chairman) and including the Service Deputies for S&T, the Deputy Director of the DIA, and the Deputy Director of DARPA. (The current S&T committee for the DAB contains the core of this group.)

The guidance should be reviewed and approved at a senior level, specifically: DDR&E, the appropriate S&T Program Secretariats of the Services, the Directors of S&T activities from the Services and other DoD agencies, representatives from the JCS, and representatives from the Intelligence communities. DDR&E, under the authority of the USD(A), will then issue the DoD S&T Guidance to the Services and other DoD Agencies and direct them to develop coordinated investment strategies. This guidance document should also be used as input to the broader Defense Guidance issued by the Secretary of Defense and the more detailed operational objectives documents issued by the JCS.

Establishment of the first DoD S&T Guidance document will be the most difficult; thereafter, except for ad hoc policies and directives (e.g., training and education), the guidance should not change rapidly from year to year unless there are sudden changes in the threat, national policy, funding, or technological capabilities.

2. The Service/Agency Investment Strategies

Upon receipt of the DoD S&T Guidance, the Service Secretaries and DoD Agency Directors should prepare specific guidance for their respective organizations, adding their vision of specific Service/Agency needs. The Services and Agencies will then develop their individual S&T Investment Strategies. This is much in the same way as is currently done, but with a consistent scope and guided by the DoD S&T Guidance. The S&T Investment Strategies will then be presented to DDR&E for review. The Service/Agency Investment Strategies should focus on the same time frames as the DoD S&T Guidance:

Near Term - current system upgrades

Mid Term - next generation systems

Far Term - notional systems/new concepts.

It is recommended that the S&T Investment Strategies address specific goals, with summaries of mission and technology areas and assessments of program risk. They should reflect coordination among the Services and Agencies and provide guidance to field activities regarding research and development and technology transition, including current and planned resources. The S&T Investment Strategies should contain discussions of the following areas:

1. Existing and projected war fighting environment
 - based on DoD S&T Guidance
 - Service specific.
2. Operational requirements
 - mission impact
 - capabilities needed.
3. Broad system concepts
 - to meet war fighting options
 - to overcome performance shortfalls.

4. Key Technology Thrusts

- permit system options
- fill gaps in capabilities
- exploit emerging technologies.

The technology thrusts described in (4) will be directed toward the operational and broad system concepts described rather than at the programmatic level.

3. OSD Investment Strategy Review

The Service/Agency S&T Investment Strategies should be reviewed by DDR&E to assure they are coordinated and consistent with the DoD S&T guidance. The investment strategies should be reviewed together with mandatory attendance by all Services/Agencies. This will enable DDR&E to assure joint Service and/or Service/Agency programs, where appropriate, are initiated and any gaps or overlaps in the overall S&T Program are identified. Some iteration will be necessary to achieve coordinated investment strategies. When satisfied that the individual investment strategies are coordinated, OSD should document this in a DoD S&T Investment Strategy document. The DoD Investment Strategy consists of the DoD S&T Guidance combined with the Service/Agency Investment Strategies and a summary chapter of the consolidated DoD investment strategy.

4. Measurement of S&T Planning Effectiveness by Feedback

The fundamental criterion for S&T planning effectiveness is the degree to which technology is made available to address operational shortfalls. The major process for measuring effectiveness is contained in feedback from the program coordination process to the investment strategy, which is part of the review process shown in Figure 1, above. This will illuminate progress by the Services and Agencies in executed programs toward the planned goals set forth in the Investment Strategy. A direct measure of progress over time is the successful insertion of technology into operational systems.

5. The Benefits of Strategic Planning

If the planning process recommended above is effective, then:

- Instances of technological surprise will be infrequent, and hence major redirection in the S&T program will be infrequent.
- Little real duplication of research topics and facilities within and between Services will be found.

- S&T budgets and level of effort will be stable within the constraints of the federal budget cycle as a fraction of DoD TOA.
- S&T advocacy by OSD and Congress will become stronger since S&T will become more apparently integral with the total RDT&E program and more readily justified.
- Time for technology transition will be reduced and a greater fraction of the S&T projects will make the transition to development programs.
- Centers of expertise, in particular technology areas, will develop and will gain intra- and inter-Service recognition for leadership in specific areas.
- It will become increasingly possible to attract and retain highly talented scientists and engineers in needed disciplines due to the clear definition and stability of research missions.
- There will be an increase in the formation of stable defense laboratory/university/industry teams in specific technology areas with well-defined roles for each.

Appendix A

WORKING GROUP A MEMBERS

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- Mr. Donald Ciffone
Chief, Advance Sys Research Office
Aviation Research & Technology Act.
Ames Res. Ctr, MS 219-3
Moffet Field, CA 94035-1099

Telephone: (415) 694-5581
Autovon: 359-5581
FTS 464-5581
- Dr. Fred Diamond
Chief Scientist
RADC/CA
Griffiss AFB Rome NY 13441

Telephone: (315) 330-4512
Autovon: 587-4512
- Mr. Gary DuBro
Dep Dir for Studies Analysis, ONT
Ballston Towers #1 Rm 502
800 N Quincy St.
Arlington Va 22217-5000

Telephone: (703) 696-4453
Autovon: 226-4453
- Dr. Paris Genalis, R&AT
Staff Specialist, IR&D, Emerging Technology
The Pentagon, Room 3D367
Washington DC 20301-3080

Telephone: (202) 694-0205
Autovon: 224-0205
- Mr. Al Goldstayn
Director of Plans & Programs
DCS/Tech & Plans
HQ AFSC/XTX
Andrews AFB MD 20334-5000

Telephone: (301) 981-5445
Autovon: 858-5445
- Dr. John Harrison
PO Box 631
Chief, Environmental Laboratory
US Army Engineer Waterways Experiment Station
Vicksburg MS 39180

Telephone: (601) 634-3227
Autovon: Do Not Have
- Mr. Don Hart
Deputy Director
AFSTC/CV
Kirtland AFB NM 87117

Telephone: (505) 846-0862
Autovon: 246-0862
- Dr. Paul Kurtz
Head, R&T Department
Naval Coastal Systems Center
Panama City FL 32407-5000

Telephone: (904) 234-4660
Autovon: 436-4660

- Col. Carl E. Pedersen
Commander
US Army Medical Materiel Development Activity
Fort Detrick
Frederick MD 21701-5012

Telephone: (301) 663-7643
Autovon: 343-7643
- Mr. James Predham
DCS for Corporate Technology
LABCOM
Attn: AMSLC-CT
2800 Powder Mill Road
Adelphi MD 20738-1145

Telephone: (301) 394-4315
Autovon: 290-4315
- Dr. Stephen Sacks
Tech Base Manager
Code 1006
Naval Research Laboratory
Washington DC 20375

Telephone: (202) 767-3666
Autovon: 297-3666
- Dr. Daniel N. Viccione
Center Mgr for Tech Base Programs
Code 01V, Bldg i01
Naval Underwater Systems Center
Newport RI 02841

Telephone: (401) 841-4356
Autovon: 948-4356
- Dr. Billy Welch
Chief Scientist, Human System Div.
HSD/CA
Brooks AFB San Antonio TX 78235

Telephone: (512) 536-2903
Autovon: 240-2903
- Mr. Doug R. Wilder
Manager of Commercial Business Analysis
IBM Federal Systems Division
6600 Rockledge Drive MS 412
Bethesda MD 20854

Telephone (301) 493-1619
- Dr. Elihu Zimet
Director, AAW/ASUW/SAT Directorate
Office of Naval Technology
800 N. Quincy Street
Arlington VA 22217

Telephone: (703) 696-4771
Autovon: 226-4771

Appendix B

ARMY LONG-RANGE S&T PLANNING PROCESS

ARMY LONG-RANGE S&T PLANNING PROCESS

The Army's long range Science and Technology planning process begins with the identification of an overall strategy for funds allocation among the competing claimants on the Army's technology base resources and ends with the actual allocation of these resources to specific program elements for execution. In between are a series of ever more focused reviews to translate the strategy into action. The rest of this appendix contains the Executive Summary of one such review. It describes the process and outcomes of the Army Technology Base Investment Strategy Conference that was held from 22 February to 4 March 1988. The purpose of this conference was to provide the long range direction to the Army technology base. The results of this conference, along with shorter range goals determined at prior reviews, will be implemented in the total Army Technology Base Investment Strategy to be provided to OSD in September 1988.

Note that references to Volumes 1, 2, etc., refer to the complete Proceedings of that meeting. Also note that "technology base" in this document refers to the 6.1, 6.2, and 6.3A programs, i.e., it is the Science and Technology program in the Task Force's definition (see Glossary).

EXECUTIVE SUMMARY

I. INTRODUCTION

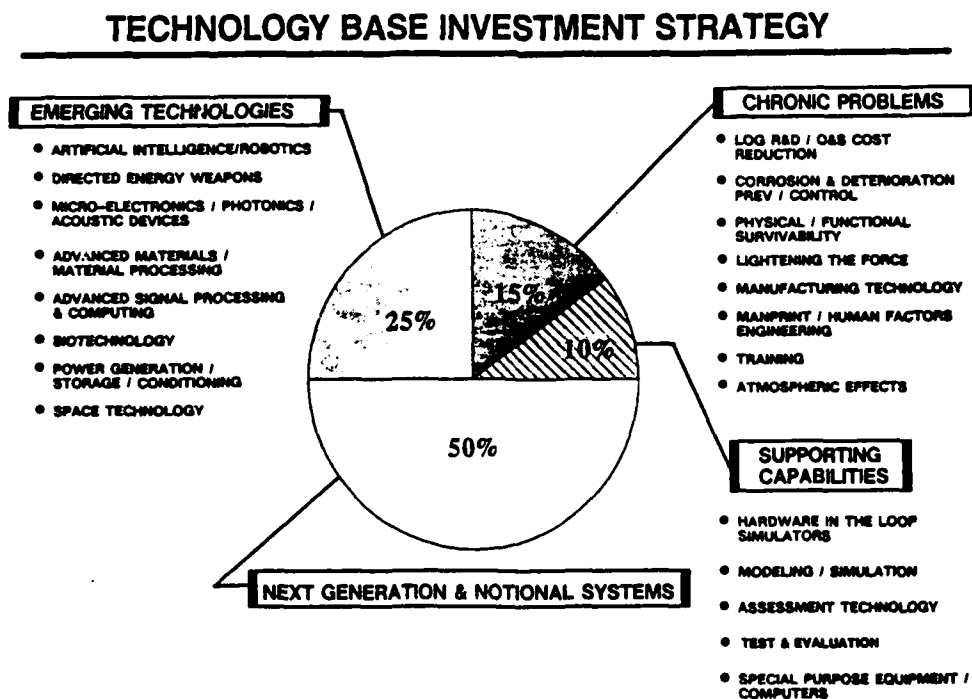
Conference Content and Process

A. Tech Base Investment Strategy

For some time the Army Materiel Command has been working to implement a long-term strategy for investing the Army's technology base resources. This evolving strategy has a central goal of apportioning technology resources across four generic areas of investment. These four areas are:

- Emerging Technologies
- Chronic Problems
- Supporting Capabilities
- Next Generation and Notional Systems

The resource apportionment goal is depicted in the following figure.



A few words of definition are in order to put the tech base strategy and the conference in perspective. *Emerging Technologies* are technology areas in which significant changes in technical capabilities are occurring as a result of research in academia, industry, or government. Emerging technologies may also be technologies that are somewhat mature, but are seen as having growing relevance to the operations of the Army.

Chronic Problems are those operational/technical problems for which no adequate solution has been found. Metal corrosion or rust is a classic example of such a chronic problem.

Supporting Capabilities are those infrastructure investments required as the cost of doing business. For example, simulators or materials processing laboratories are needed just to be in a technology endeavor.

The fourth category of investment is *Next Generation/Notional Systems* demonstrations, in hardware and software, of new military capabilities. It is in this investment category where diverse technologies are assembled and integrated to demonstrate that technical barriers have been overcome and that a new military capability is achievable.

B. Tech Base Investment Strategy (TBIS) Conference

The Technology Base Investment Strategy Conference was a two-week review and synthesis effort wherein the Army technology community reviewed ten selected emerging technologies, and speculated how such technologies could be applied to future notional systems. The conference was but one event in a sequence leading to decisions on resource investment. Other events in the sequence are war games to scope the contribution of notional systems of war-fighting capabilities and the whole 5-year programming and budgeting process.

1. The TBIS Conference was held at the Kossiakoff Conference and Education Center, Applied Physics Laboratory, The Johns Hopkins University, Laurel, Maryland, during the 2-week period of 22 February through 4 March 1988. The conference focused on the ten emerging technologies identified in the figure.

The conference program was structured to provide approximately 4-hour blocks of time for the review of each emerging technology. The information presented in these reviews is provided in detail in Volume 1, Parts A, B, and C, of the Conference Proceedings.

2. The TBIS Conference was planned to achieve a second objective, namely the synthesis of notional systems embodying the developments in the emerging technologies. Working groups were established at the beginning of the 2-week conference. These working groups met regularly, during the 2 weeks, to "brainstorm" new system concepts utilizing ideas prompted by the presentations on the state-of-the-art in the emerging technologies. There was a working group for each of the following broad areas:

- Lethality
- Mobility
- Battlefield Support
- C³I

A fifth working group was formed to plan the "play" of the synthesized notional systems in a seminar war game. The results of the work of these five groups are contained in Volume 2.

3. To assure that the notional systems synthesis of the working groups considered more than the evolution (and revolution) in technologies, the conference also included briefings on contemporary developments in operational and tactical doctrine within the Army, and national security policy at the national level. The salient points of these presentations are provided as follows and in detail in the introduction to the panel proceedings (Volume 1).

II. STRATEGY, DOCTRINE, AND TACTICS

A. A review of the current force structure of the Army and its current modernization efforts reveals one central conclusion: The U.S. Army is focused on high intensity conflict in Europe. It can be concluded that nearly all equipment developments and acquisitions are driven by possible conflicts in Europe against forces of the Warsaw Pact. The result is a heavy force, not easily relocatable to other parts of the world.

Another observation that can be made is that the systems and tactics are keyed to operations on open ground. This has some historical precedence, for traditionally armies have been trained and equipped to fight on open ground, while avoiding villages and cities.

However, recent economic developments have led to European urban sprawl and industrialization. One can therefore conclude that, in Europe at least, there is a high likelihood for urban warfare. Thus, future Army forces ought to be adaptable to fighting in cities and towns. A further implication is the need for systems that are adaptable to the short engagement ranges of urban warfare, and that operations will fall to small units for execution.

B. While the U.S. Army force structure has been focused on high intensity conflict in Europe, the Army may be called upon for missions around the world. This means that greater attention must be paid to the need of an "expeditionary force," one that is capable of quickly establishing combat power in a new theater of operations. This infers that the logistics growth associated with heavy forces must be eliminated, and new systems must be maintainable without a dedicated support structure.

C. At the present time the national security leadership is implementing a security planning and resource allocation approach called "competitive strategies." Competitive strategies requires an analysis of the strengths and weaknesses of the United States and potential adversaries. At the present time this approach is being applied principally to the adversarial relationship between U.S./NATO and Soviet Union/Warsaw Pact alliances.

III. INTELLIGENCE ASPECTS

The intelligence briefings at the TBIS Conference were provided by the Foreign Science and Technology Center and the Central Intelligence Agency.

The specific contents of these briefings is given in Volume 1. Two aspects of the briefings are particularly relevant to the Army's use of technology. First, a technology transition and insertion program technique must be developed, as part of U.S. forces development planning, that is not dependent upon a serial, go/no-go development process. Major development initiations must be structured to allow multiple choices of technology at critical program decision points so that new starts are not held up until all technology questions are settled. Otherwise, the introduction of new technologies will always lag, and no technological surprise on the battlefield will be possible.

A second aspect for consideration is the adversary's approach to exploiting technological developments in other countries. If technology is to be a point of leverage for U.S. combat power, then, on the one hand technological developments must be protected and on the other hand accelerated to force application while they still provide leverage.

IV. EMERGING TECHNOLOGY REVIEWS

Each of the emerging technology areas was presented and reviewed as a stand-alone discipline. This was done to provide a consistency with the tech base investment strategy, as well as provide a framework for organizing and scheduling the presenters. Upon reflection of the developments presented, one can conclude there is a certain synergism and connectivity in several of the emerging technologies. Therefore in the summary below, the emerging technologies are discussed in a sequence different from the actual conference presentations. This is done to show this connectivity in the growth of the technologies.

A. Microelectronics

Developments in the area of microelectronics, now and through the early 21st century, will determine and pace developments in artificial intelligence, advanced signal processing, and robotics. This does not mean that microelectronics now limits these other technologies. Quite the contrary is true. Rather, as developments in microelectronics proceed, opportunities expand in these other technologies.

Developments in microelectronics have been truly spectacular in the last 40 years starting with the invention of the transistor in 1947, through the invention of integrated circuits, and very large-scale integrated (VLSI) circuits of today. Microelectronics as an emerging technology is not near an identifiable peak. The most recent advances—Very High Speed Integrated Circuits (VHSIC), microwave integrated circuits, and expanded use of different materials such as gallium arsenide—appear to be just another step along the way to much denser and hence much faster microelectronic circuits.

Much of the advance in microelectronics has been measured in terms of the number of devices or functions that could be packed on a single chip. The VHSIC Phase I program, using device feature sizes in the one micron range, has resulted in the ability to place 10^6 to 10^7 functions on one chip. The VHSIC Phase II program is expected to result in a 100 times increase in density of functions on a single chip.

The current silicon-based VLSI/VHSIC technological approaches are expected to evolve incrementally and reach their limits by the mid-1990s, principally due to characteristics of the materials and resulting time delays inherent in interdevice connections. However, as these limits are approached, use of gallium arsenide and other semiconductor materials are expected to allow the pace of advances in microelectronics to go unabated. Gallium arsenide and similar materials allow very high speed charge transfer in the devices, permitting even higher speed than that achieved in the VHSIC program. But gallium arsenide also opens up a whole new class of microelectronic device capabilities since gallium arsenide devices can be used to generate both millimeter wave and optical radiation. Now there is the basis for millimeter-wave/photonic integration.

Devices, based upon the propagation of acoustic waves through a material such as quartz, are commonplace in modern electronic systems. Both acousto-electric and acousto-optic devices are now in development and are used as oscillators, filters, and delay lines. Gallium arsenide is a material that has piezoelectric, electronic, and optical properties. The future thus holds promise of integrating acoustic, electronic, and optical components in a monolithic integrated circuit.

B. Advanced Signal Processing

Closely allied to the developments in microelectronics are the advances being made in signal processing. Present signal processing is principally accomplished by digital data processors whose recent advances (VLSI, VHSIC) permit very high speed, programmable data processing. It is estimated that over 90% of signal processing requirements are satisfied by digital signal processing techniques. Digital processing, though permitting programmability, requires digitizing the signal in the first place. Most signals of military interest—radar return, infrared radiation, communications transmissions—exist naturally as analog signals. The recent advances in microelectronics discussed above, particularly the developments in photonic and acoustic devices, now permit signal processing to be done on analog processors. This allows signal processing bandwidths of an order of magnitude greater than with digital technologies. Beyond this, however, is the advent of hybrid processors combining both analog and digital techniques in one processor, thereby gaining bandwidth, dynamic range, and programmability in a single processor.

Along with the development of this processor componentry, there is much progress in the area of signal processor architecture. New systematic approaches have been developed in tailoring processor designs to a specific application.

In the case of VHSIC, a VHSIC hardware descriptive language (VHDL) has been developed, which uses the same language at the system level, down to the macro cell level of the chip. The language can simulate the system performance based on system functionality. It contains a library of VHSIC chip designs, allowing a designer to design a processor, using only input and output design parameters.

Another innovation in digital signal processing is the Enhanced Modular Signal Processor. This parallel processor uses a graphic programming approach in which the designer provides a graphic description of the signal processing operations. This approach greatly reduces the number of lines of code, and provides a means to update readily and maintain processor code as signal processing requirements change in the field.

Along with the development of digital and analog processor hardware and new approaches to its design and integration into the signal processing world, there is being introduced two other developments. The first is sensor fusion and artificial intelligence. With the tremendous computing power provided by the new digital and analog devices, it is now possible to merge data from two different sources, for example radar and infrared sensors, and process the data from both, in a single processor, to achieve higher probabilities of detection, and higher confidence in identification. Because of the capabilities of the new signal processing devices, data fusion and interpretation, which was formerly done by humans and by discrete ground-based machines, can now be done by autonomous processors in robots, missile seekers, or unmanned aerial vehicles.

Along with the ability to simultaneously process two (or more) signals in a single processor, artificial intelligence and expert systems "rules" are being developed, which can be programmed into the signal processor. This has the potential of introducing "very smart" processors into small, autonomous systems.

C. Artificial Intelligence

Artificial intelligence, the idea of having machines do human-like thought processes, has advanced greatly over the last few years. Much of the advance in artificial intelligence has been made possible by the great increases in computational speed, available memory, and system reliability. Coupled to this hardware development is the development of rules, or software, for more efficient manipulation of large amounts of information, often from diverse sources.

Artificial intelligence, and particularly "expert system" technology, is expected to permeate and enhance every aspect of Army operations and business. For tactical operations, artificial intelligence processors are expected to be imbedded in weapon systems, command and control, intelligence processing, tactical planning, and logistics. For business operations, artificial intelligence will be applied to contracting, personnel planning and services, wholesale logistics, and manufacturing.

While artificial intelligence techniques will be developed and applied, it is not yet obvious that adaptive and self-learning systems can or will be developed. The observation has been made that humans can be taught, but machines must be programmed, leading to tempered optimism with regard to the future of artificial intelligence.

D. Robotics

Robotics, as a technology, is a combination of several technologies integrated to produce a machine capable of performing functions that in the past needed human interaction for initiation and control. Thus modern robotic systems embody much of the recent developments in sensors, information processing, and actuators in a real-time, closed loop system. The advances made in sensors—acoustic, optical, tactile, and chemical—along with advances in signal processors and small computers, allow the development of robots capable of performing industrial and logistic functions with very little human interaction.

Advances in navigation technologies, image analysis, and scene comparison, allow robotic vehicles to navigate and acquire targets. As a result, it is projected that highly autonomous robotic systems can be developed to execute a variety of hazardous, or manpower intensive functions on the battlefield.

E. Advanced Materials and Processing

As developments in microelectronics have been the key to advances in signal processing and artificial intelligence, progress in materials and material processing has been, and will be the key to development in other technologies, particularly structural and armor systems, prime power, and electric power generation and conditioning.

Key developments in materials are occurring in alloys, ceramics, composites, and superconductors. The key developments are achieved more by innovative processing technologies than by formulations of new compounds. Whereas traditionally materials were prepared at the "ingot" level, modified and machined, new metals are made "from the atom up." Control of composition, microstructure, properties, and shapes are now possible.

New bonding technologies are being developed that offer the benefits of "jointless" joints and the ability to join single crystals into larger crystals for metal/ceramic, ceramic/ceramic, and metal/metal matrix composite joining.

Advances in composites continue to be made in the matrix materials, the reinforcing constituents, and the architecture and/or reinforcement geometries. Polymer matrix composites provide new opportunities for weight reduction, corrosion protection, and reduced radar cross section, along with tunable electric and mechanical properties. Ceramic matrix composites offer unique dielectric, magnetic, and optical properties that can be exploited in military system designs.

While alloys and composites open new horizons for structural components, new materials are being developed for electric, electronic, and optical systems. Most notable for electric and electronic applications is the discovery and formulation of "high temperature" superconductors. While the long-term goal of superconductors research is a room temperature superconductor, even those that operate at liquid nitrogen temperatures allow signal detection and signal processing systems that have hitherto been impractical.

Parallel to the development of high-temperature superconductors is the complimentary development of rare earth magnetic materials. These materials are finding application in more efficient electric power generators and RF energy generation.

F. Power Generation and Conditioning

Advances in new materials are having a most immediate impact on power generation, conditioning and storage. New ceramic materials are being applied to prime power sources such as reciprocating and rotary engines. Ceramic bearings and ceramic-coated parts allow increased engine-operating temperatures and reduced friction resulting in overall increases in engine efficiencies of up to 50%.

Materials development is also having a major impact on energy storage in capacitors and batteries. The new ability to design molecular materials of very high dielectric strength has permitted three orders of magnitude increase in energy density in large capacitors such as needed in pulsed power systems. Similarly, new materials and new material-processing techniques are leading to major advances in battery design. Developments in anode/cathode materials and electrolyte materials is resulting in high energy density, rechargeable batteries.

G. Directed Energy Weapons

The concept of directed energy weapons has been around for about two decades, at least since the first high energy lasers were conceptualized. However, there have been fundamental problems standing in the way of weaponization of directed energy weapons for Army application. Among these problems has been the development of pulsed power supplies of small enough size that the weapon could be called a "tactical" weapon.

While laser systems have been conceptualized for operation in the visible optical and infrared region of the electromagnetic spectrum, recent developments in microwave energy generation have resulted in high power microwave (HPM) weapons concepts. HPM weapons also require high energy pulsed power systems for operation.

High energy laser and HPM weapon concepts are approaching realization with the advances being made in storage capacitors, more efficient prime power sources, and energy conversion devices like homopolar generators. Continued advances in high temperature superconductors will also contribute to further development of directed energy weapons.

Charged particles beam weapons is a third type of directed energy weapon that has been under research and development. At the present time no clear path is seen to resolving the issues of accelerator size, beam propagation, and tactical beam pointing.

By the year 2000, one can expect that some form of laser and HPM weapon will be available for development and deployment. However, these weapons will likely have their earliest utility in augmenting existing weapons systems, through soft kill of optical and electronic subsystems.

H. Space Technology

For the Army, utilization of space to support military operations is both an old and new endeavor. Since the mid-1950s the Army has been associated with the development of technology to exploit space. Principal among these endeavors has been strategic defense and satellite communications. Within the past 4 years, however, in concert with overall national policy, the Army is endeavoring to use space-based assets in direct support of tactical ground operations. This goal is becoming more achievable and practical as a direct result of the technology developments in microelectronics, signal processing and power generation. Just as important as device technology has been the introduction of space system concepts embodying low cost launch vehicles, and low cost space assets designed for short duration missions instead of multi-year missions.

With existing and near-term space technology and systems, by the year 2000, the Army can have real-time weather and terrain data available to any echelon, worldwide position and azimuth sufficient for maneuver and fire support, and space-based ground and air target detection and tracking.

I. Low Observable Technology

Low observable technology endeavors have as their goal the reduction of infrared, radar, visible, and acoustic signatures of military equipment. The basic physics of signature reduction has been known for many years. However, computer-aided design techniques, coupled with the ability to design "to order" signature reduction materials, have made signature reduction an engineering discipline in its own right. Contributing most to the success of signature reduction efforts has been the advent of composite materials for structural components, ability to perform computer-aided analysis of complex structures, and a disciplined system approach to overall signature reduction.

J. Biotechnology

Biotechnology is the newest area of military research. The principal lines of investigation are in the areas of medicines, materials, hazardous material detection and clean up, and food production. The Army's principle investment in biotechnology are in the areas of medicine—vaccines and drugs—and chemical and biological detection and decontamination. Research to date, which is closely coupled to academia and industry, indicates near-term availability of vaccines for militarily significant diseases, and rapid biodetection of minute quantities of CW agents. In the longer term, biotechnology efforts can be expected to yield tailored enzymes for decontamination and waste clean up.

Biotechnology research is also resulting in a class of new materials derived from or patterned after existing natural materials. Examples of such endeavors are synthetic silk based upon the biological structure of natural silk and new adhesives based upon structures of natural adhesives produced by mussels, which can glue themselves to rocks even in the presence of salt water.

The potential of biotechnology research is just beginning to be understood. By the year 2000 the enormous investments by industry are expected to produce spectacular results, especially in the field of tailored medicines.

V. NOTIONAL SYSTEMS SYNTHESIS

To achieve the second objective of the TBIS Conference, namely the synthesis of notional systems based upon the emerging technologies, the conference participants were asked to serve in one of the working groups. Each working group was cochaired by a senior officer of the Training and Doctrine Command, and a director from one of the R&D Centers of the Army.

Four of the working groups were focused toward broad technical/operational areas—lethality, mobility, battlefield support, and C³I. The scope of these groups was not more sharply defined at the start, to allow development of innovative systems concepts outside the current notions of guns, tanks, helicopters, and missiles. The working group members were allowed and encouraged to give free rein to their imaginations and produce system concepts that may or may not have an obvious place in current force structures or development agencies.

The working groups met periodically throughout the 2-week conference, and on the last 2 days reported their results to the whole conference. Over a hundred new or technologically updated system concepts were developed in the conference. The detailed reports of the working groups are contained in Volume 2 of the proceedings. What follows below are some highlights of each working group's report.

A. Lethality

The Lethality working group structured its synthesis efforts to consider the whole depth of the battlefield—deep attack to rear area; the range of targets—personnel, armored, logistics, C³I; and the specific task to be done against these targets—destroy, delay and deny. To put its synthesis efforts in the context of Army operations in the post-2000+ timeframe, the Lethality working group postulated five system-common axioms:

- reduce manpower
- reduce vulnerability
- increase lethality
- enable better battlefield synchronization
- increase sustainability.

To provide indirect fire attack on targets, the Lethality group conceptualized three principal systems—an autonomous howitzer system, a long-range missile system, and an intelligent mortar battery. The howitzer system is characterized by its ability to conduct fire support on a highly dispersed battlefield without centralized control. In addition, it is expected that it would be carried on a medium-weight chassis.

The intelligent mortar battery was visualized as consisting of one-man portable launch tubes, guided rounds, and possibly a "robotic forward observer."

A future direct fire system was synthesized, which would perform the close combat role of the present tank. However, the new system would have new weaponry, be carried on a medium-weight chassis, and have considerable commonality with the indirect fire howitzer system.

The Lethality group also synthesized a class of smart mines embodying the signal processing capabilities and the kill mechanism projected for the post-2000 timeframe. Included in the new set of mines are those that do target discrimination and which have lethal mechanisms tailored to the target.

B. Mobility

The Mobility group was particularly aggressive in conceptualizing systems that exploit developments in materials, power generation, microelectronics, robotics, and artificial intelligence. The mobility systems were divided into two broad classes—air mobility systems and ground mobility systems. Both classes were synthesized from the start to provide reduced manpower requirements, increased survivability, and reduced operations and maintenance costs.

The air mobility notional systems consisted of two categories (manned and unmanned) and served three functions (attack, logistics, and IEW). The unmanned air mobility systems are based upon full exploitation of unmanned aerial vehicles under the control of ground stations, or a mother aircraft. In either case, several unmanned air vehicles would simultaneously be under the control of one control systems or mother aircraft. Full exploitation would be made of low observable technologies and materials, microelectronics, and artificial intelligence to make the aerial vehicles highly survivable and nearly autonomous. These unmanned air vehicles would be capable of carrying out lethal strike missions and logistics resupply, as well as deep penetration IEW missions.

A family of logistics air mobility systems was conceptualized. This family of logistics systems is seen as a combination of lighter-than-air, tilt/folding rotor, or advanced rotor craft. Again materials, microelectronics, and artificial intelligence techniques would be applied to reduce manpower requirements and provide all weather operations. These would be a combination of both manned and unmanned systems.

In the area of manned aircraft, a highly automated single pilot aircraft was visualized. It would be capable of executing both ground attack and air-to-air missions, through exploitation of low observable techniques, signal processing and sensor fusion advances, and artificial intelligence.

Ground mobility notional systems also consisted of two categories—manned and unmanned. Advances in materials, power generation, and robotics are seen as having the potential of permitting the payloads of logistic vehicles to equal their curb weight, their fuel efficiency to increase to more than 100 ton-miles per gallon, and be convertible to robotic convoy following to allow one-man logistic convoys.

Robotics are seen as playing a key role in highly survivable platforms for reconnaissance or attack missions. These robotic systems would operate semi-autonomously under the control of either a land- or air-based controller. Reduced bandwidth communication links will be possible through the use of onboard sensor fusion and autonomous navigation subsystems.

An advanced medium-weight armored platform was synthesized to serve as a basis for resupply, command and control, and long range anti-armor weapon systems. This medium-weight platform, in the 25-ton class, would have a 60% reduction in fuel consumption compared to current systems. This would be achieved through use of advanced materials and high density power cells with electric drive transmissions.

A heavy armored platform was synthesized as a platform to support armor, infantry, artillery, and air defense missions. However, this heavy armored platform would weigh only 40 tons compared to 60-ton systems of today. Much of the weight savings are attributable to reductions in the predicted volume. Crew size will be reduced to two men. Armament systems will use robotic autoloaders, and more efficient engines and transmissions will allow reductions in engine size and full storage. All of these will permit major reductions in protected volumes.

C. Battlefield Support

The scope of the Battlefield Support Working Group was quite large, spanning subject areas from weather and terrain analysis, chemical detection, and over-the-shore logistics. As a result the Battlefield Support Group divided its efforts into several subcategories:

- Terrain, Weather and Space
- Obstacle and Counter Obstacles
- Survivability and Sustainment Engineering
- Camouflage, Concealment, and Deception
- Logistics
- Individual/Collective Protection, and
- Sustainment

Weather and terrain analysis and prediction is expected to make full use of space- and ground-based sensors in providing real-time subscriber type service to all echelons of the force. Weather and terrain data are seen as a subject of a battlefield knowledge system-of-systems supported by and integrated into the C³I architecture of the force. Position and navigation of logistic and combat elements will be provided by an extensive net of space-based references as well as self-continued initial systems.

The Battlefield Support Working Group synthesized a variety of countermobility obstacles. Principal among the system concepts is a family of mines that utilizes a variety of sensors to attack vehicles, helicopters, and low-flying aircraft. The mine systems are seen as programmable to discriminate against friendly and threat entities, and remotely controllable for arming/disarming and status reporting. The "brains" of these mines would exploit the development in signal processing achievable in small sizes resulting from advances in microelectronic components.

Counter obstacle systems consisted of both old and new ideas. Mine detection, minefield marking, and minefield breaching are seen as continuing problems for which there are no revolutionary ideas. The crossing of natural barriers is seen as an obstacle problem that is amenable to the use of advanced materials for bridging and floatation devices. A "foam-in-place" bridge and an air cushion bridge were synthesized as alternatives to standard military bridging.

Chemical hazard areas are seen as significant mobility obstacles. Here space-based detection systems, and biotechnology-based detection and decontamination systems are seen as the next century's means of dealing with chemical hazard obstacles.

Survivability and sustainment engineering is expected to benefit from the use of advanced materials and chemicals that can be used to stabilize or strengthen soils. The goal is to use local materials to the maximum extent possible to reduce logistic burdens.

Camouflage, concealment, and deception (CCD) operations are expected to benefit principally from advances in tailored materials, efficient power generation technologies, and frequency tunable lasers. The Battlefield Working Group's CCD ideas included multispectral tactical camouflage kits with components for both fixed and movable assets, landscape alteration kits including dyes and radar reflectors, and activity simulators. Such systems could simulate lines of communication, C³ modes, and defensive positions, thus creating false targets for enemy recon systems.

Logistics operations are seen to benefit from three technology areas: advanced materials, space-based data, and artificial intelligence/expert systems. New materials are projected to be available to stabilize roads and runways. Over-the-shore logistics could be assisted by mobile breakwater systems, fabricated of advanced materials, to permit over-the-shore operations through sea state 3. Weather and terrain data will be used to project sea states, trafficability, and visibility. These data would be used in an artificial intelligence/expert system planning model to derive optimized logistics operational plans on a near real-time basis.

Chemical and biological protection and sustainment systems are expected to emerge from technology development in space-based sensors and communication, from biotechnology-based sensors and decontamination methods, and tailored advanced materials. Chem/bio hazards will be detected and reported through a network of space- and land-based detectors and communication links. The chemical and biological hazards themselves will be dealt with using emulsions that catalytically react to chem/bio agents and coatings that can be sprayed on before an attack.

D. C³I

The C³I Working Group took as its challenge the providing of the right information, at the right place, at the right time. In doing so, it visualized the C³I systems and techniques as the means used to integrate lethality, mobility, and battlefield support systems into an "integrated war-fighting system."

The C³I group postulated five design goals as principles to guide its notional systems synthesis. These are:

- Continuity
- Versatility
- Simplicity
- Security, and
- Homogeneity

These were applied to a battlefield that was seen in the year 2015 as being wider, deeper, and higher than practically any place in the world.

The C³I tasks are twofold:

- Acquire, manage, distribute, and exploit information for friendly operations.
- Deny the enemy collection, distribution, and use of information.

To accomplish these tasks the C³I Working Group conceptualized four generic top level systems. These were an information transport system, an information management system, an information collection system, and an information denial system.

Information transport on the battlefield is expected to make maximum use of the developments in microelectronics, space, and signal processing. These technologies will allow fully distributed, dispersed, adaptive, and transparent voice and data communications throughout the battlefield and theater of operations. Local area information transport systems will support highly mobile fighting units. Key elements of the local area system will be combat radios with embedded processors, which allow these radio/processors to support automatic relaying, dynamic routing, and network management.

Closely coupled to the local area information system are range extension subsystems consisting of space assets, manned and unmanned aerial platforms, and meteor trail communications. These assets are integrated into the information transport system as interconnect modes at all echelons.

Wide area information transport will be accomplished through intelligent switches that integrate radio and land line communications hardware. These intelligent switches, using artificial intelligence techniques, will adapt the wide area network in response to enemy action, user requirements, and friendly deception plans.

The information management systems will utilize microelectronic, signal processing, and artificial intelligence developments to provide presentation and management of information. At the lower echelon information management and display will be highly integrated with the C2 systems to provide real-time situation to the individual soldier up through battalion level. At the higher echelons, information management systems will integrate, display, and distribute information across the functional areas in forms usable in joint and combined operations.

The future information collection function is seen as being accomplished by a large variety of manned and unmanned sensors, connected in an architecture that in essence provides a distributed collection and fusion capability. Included in the sensor set would be multispectral sensors on manned platforms such as helicopters and combat vehicles, as well as tailored collection platforms such as UAVs and satellites. This collection architecture will make full use of the developments in integrated sensors and signal processors to achieve reduced bandwidth data streams, and target identification. Data fusion will be supported at various echelons with artificial intelligence-based analysis and decision aids.

Denial of enemy collection and use of information will be accomplished through a set of jamming, protection, and deception systems. Signal jamming will be accomplished through reprogrammable jammers exploiting new efficiencies in optical and radio frequency devices. Directed energy devices are seen as having a unique role in this regard. Communication and radar jammers are expected to benefit greatly from the advances made in acoustic-optic processors.

Self-protection systems are expected to use the advances made in microelectronics, signal processing, and artificial intelligence. These technologies will be applied to achieve high efficiency, frequency agile, and adaptive systems.

In support of denying information to the enemy the C³I working group considered an integrated deception system concept. This system was seen as being based upon the availability of light-weight, efficient energy sources, and robotic subsystems for deployment. The deceptive system would also contain subsystems for entering false data into enemy command, control, and communications networks to cause overload, disruption, and delay.

In summary of their work, the C³I working group emphasized the need for integration across the working groups and proposed additional integrated sessions for the future.

VI. CONCLUSIONS

The 2-week TBIS Conference provided the Army technology community a unique opportunity to assess developments across a wide range of research and development activities. There are many technological developments on the horizon that can lead to much more capable soldiers, much reduced logistic loads, more lethal weapon systems, and more effective command and control.

No new technology breakthroughs were seen that would radically change the nature of war. However, it is clear that the combining of technological developments from diverse areas of research can lead, and is indeed now leading, to radically new system concepts and hence to new concepts of battle and future force structures. The principal conclusion derived from the synthesis of notional systems by working groups was the universal requirement to consider the Army as a "system-of-systems." There is evolving a need for a closer integration of systems in the concept, development, and fielding stages. Without such a total systems approach, the promise of the emerging technologies cannot be converted into militarily significant combat power.

Appendix C

NAVY LONG-RANGE S&T PLANNING PROCESS

NAVY LONG-RANGE S&T PLANNING PROCESS

The following describes the planning process and the current plans for the 6.2, Exploratory Development, portion of the Navy S&T program. The first document gives the established procedures. This is followed by a set of vugraphs extracted from a briefing given to the Core Group outlining the 6.2 planning process.



DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL RESEARCH
ARLINGTON, VIRGINIA 22217-5000

IN REPLY REFER TO

OCNRINST 3910.3
20P

11 MAR 1987

OCNR INSTRUCTION 3910.3

From: Chief of Naval Research

Subj: EXPLORATORY DEVELOPMENT PROGRAM POLICIES, PROCEDURES AND
RESPONSIBILITIES

Ref: (a) SECNAVNOTE 5430 of 29 September 1986
(b) Title 10 of the U.S. Code (Article 5150-51) (NOTAL)
(c) OCNRIINST 5430.1
(d) CNO ltr OPNAVINST C3501.2G Ser 642E/5C271468 dtd 3 Sep 1985 (NOTAL)
(e) ASN(R,E&S) memo of 7 May 1985 (NOTAL)
(f) CND memo 7133 Ser 07B-123 of 12 June 1985 (NOTAL)

Encl: (1) Mission Area Strategy Format
(2) Naval Warfare Mission Areas and Corresponding 6.2 Program Mission
Areas
(3) Exploratory Development Definitions
(4) Block Plan Format
(5) Program Change Recommendation (PCR) Format
(6) Task Summary Format and Entry Description
(7) Monthly Block Program Funding Report
(8) Block Quarterly Report Format and Preparation Guidance
(9) ONT Program Reviews

1. Purpose. To publish policies, procedures, and responsibilities for
conduct of the Navy Exploratory Development (6.2) program in amplification of
references (a) through (f).

2. Cancellation. NAVMATINST 3910.20A.

3. Applicability. This instruction applies to all Department of the Navy
(DON) category 6.2 RDT&E,N programs.

4. Program Objectives. The objectives of the 6.2 program shall be to:

a. Maintain Navy technological superiority and provide the capability to
counter new threats so as to reduce the risk of executing the full Maritime
Strategy;

b. Provide technology opportunities that:

(1) Preserve the strategic Naval initiative and extend strategic
flexibility;

(2) Improve the effectiveness of the U.S. deterrent posture;

(3) Present significant threats to U.S. adversaries.

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c. Provide technology that reduces cost of acquisition and operations and maximizes system cost-effectiveness.

5. Policy. It shall be the policy of the Office of the Chief of Naval Research (OCNR) to:

a. Conduct a 6.2 program founded upon and managed according to the technical merit and operational worth of its developmental projects;

b. Structure the 6.2 program and its investment strategy to support the Navy Maritime Strategy, its warfighting objectives and Warfare Appraisals.

c. Ensure that the 6.2 program is harmonized with the Navy's current and anticipated Research, Development and Acquisition (RDA) thrusts;

d. Achieve integration of 6.2 program objectives with those of higher categories of RDT&E.

6. Accountability. The accountability and organizational relationships of the Chief of Naval Research (CNR) are provided in reference (a). The CNR reports to the Secretary of the Navy (SECNAV) for policy and guidance in the conduct of the Department of the Navy Basic Research and Exploratory Development programs. In addition, the CNR is responsible to the SECNAV for planning and executing the DON Basic Research program as well as the functions in reference (b). The CNR serves as an advisor to the Chief of Naval Operations (CNO) and the Commandant of the Marine Corps (CMC). The CNR is responsible to the CNO for the effective planning and direction of the Exploratory Development program.

a. The specific organizational relationships between the CNR and SECNAV for the Exploratory Development program are as follows:

(1) CNR is responsible to SECNAV for overall investment strategy and balance of the DON Exploratory Development program;

(2) CNR is responsible to SECNAV for management, planning, direction, and control of the operation of the assigned activities, centers and laboratories.

b. The specific organizational relationships between the CNR and the CNO for the Exploratory Development program are as follows:

(1) CNR is responsible to the CNO for developing research and technology programs which effectively address future operational naval needs and capabilities;

(2) CNR is responsible to the CNO for Exploratory Development program planning and direction.

c. Within OCNR, the Director, Office of Naval Technology (ONT) is responsible to the CNR for managing the Exploratory Development Program.

7. Responsibilities. The responsibilities of various organizations with respect to the planning and execution of the Exploratory Development Program are delineated as follows:

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a. Office of Chief of Naval Research. The mission statement for the Office of the Chief of Naval Research is given as follows (reference (c)):

"To plan, foster, and encourage scientific research in recognition of its paramount importance as related to the maintenance of future naval power and the preservation of national security, and to provide for both basic research and exploratory development (R&D) needs of the Department of the Navy (DON), including program planning and execution of research and of exploratory development programs; to plan, manage and use R&D laboratories and activities assigned to the CNR; to provide technical advice to the CNO and the Secretary of the Navy in areas of research and exploratory development; and to perform such other functions and tasks as may be directed. The Office of the Chief of Naval Research (OCNR) consists of two lead offices: the Office of Naval Research (ONR), and the Office of Naval Technology (ONT)."

b. Office of Naval Technology. ONT's responsibilities are to:

- (1) Develop Investment and Mission Area Strategies in consonance with higher-level guidance provided by OSD, SECNAV, CNO and CMC;
- (2) Conduct the 6.2 Planning, Programming, and Budgeting (PPBS) System;
- (3) Provide program planning and execution guidance to Claimants and performers;
- (4) Provide review and approval of program plans;
- (5) Allocate funding and ensure fiscal accountability;
- (6) Provide oversight of 6.2 program execution;
- (7) Directly manage execution of selected portions of the 6.2 program when (a) circumstances dictate that close and continuing headquarters oversight and control is necessary, (b) the effort funded pursues an innovative idea proposed directly to ONT by the private sector, or (c) the work falls outside the scope of the block programs.
- (8) Represent and defend the 6.2 program to higher authority;
- (9) Interface with the SYSCOMs; OPNAV; Headquarters, Marine Corps; and the Navy Secretariat;
- (10) Support the CNR and others, as appropriate, in their interactions with OSD and the Congress.

c. Navy Systems Commands (SYSCOMs). SYSCOM roles and functions with regard to the Exploratory Development program shall be as follows:

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- (1) Serve as principal advisors to ONT in the development of the overall DON Exploratory Development Program Investment Strategy, and in the development of the individual Mission Area Strategies;
- (2) Develop and provide to ONT, documented, prioritized system technology needs;
- (3) Participate in the block program planning and review process. In particular, review laboratory-generated block program plans and provide recommendations concerning those plans to ONT;
- (4) Manage those assigned programs determined to be best executed by the Systems Commands;
- (5) Provide independent technical assessments of the value of the Exploratory Development program products and assess their value to ongoing and future SYSCOM development programs;
- (6) Work in partnership with ONT and the Navy Laboratories/R&D Centers to facilitate technology transition to systems programs, by providing appropriate transition interfaces and developing and implementing transition strategies and plans.

d. Navy Laboratories and R&D Centers. The responsibilities of the Navy Laboratories and R&D Centers with respect to the Exploratory Development program shall be as follows:

- (1) Plan and execute effective block programs by:
 - (a) Making use of the best technical capability available both internal and external to the Navy;
 - (b) Providing management of the in-house and contractual efforts needed to accomplish assigned block programs;
 - (c) Integrating efforts among contributing laboratories;
 - (d) Integrating contributing contractor efforts;
 - (e) Minimizing unwarranted duplication of facilities;
 - (f) Promoting cooperation among Navy Laboratories thereby increasing the collective effectiveness of the Navy Laboratory system.
- (2) Work in cooperation with the SYSCOMs and ONT to promote technology transition of mature 6.2 projects to higher category programs;
- (3) Provide security management for assigned programs;
- (4) Maintain communication with SYSCOM Commanders regarding the exploratory development Blocks/Projects assigned to Laboratories and R&D Centers.

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e. Marine Corps (MARCOR). MARCOR roles and functions with regard to the Exploratory Development program shall be as follows:

- (1) Advise ONT in the development of the overall DON Exploratory Development Program Investment Strategy, and the Amphibious Warfare Mission Area Strategy;
- (2) Develop and provide to ONT documented Marine Corps needs and priorities applicable to the Exploratory Development program;
- (3) With participation from the Navy Laboratories/R&D Centers, develop, manage and execute the plan for the MARCOR portion of the 6.2 Program;
- (4) Conduct management and technical reviews of the work and output of the Navy Laboratories/R&D Centers and contractors supporting the MARCOR 6.2 program to assess their progress and value to the program;
- (5) In partnership with the Navy Laboratories/R&D Centers, develop realistic and timely plans to transition promising 6.2 projects into advanced development programs.

f. Office of Naval Research (ONR). ONR Applied Research and Technology Directorate's (ONR Code 12) roles and functions with regard to the Exploratory Development program shall be as follows:

- (1) Advise ONT in the development of the overall DON Exploratory Development Program Investment Strategy and in the development of the individual Mission Area Strategies;
- (2) Working closely with ONT and other parts of ONR, identify high-leverage opportunities for joint research and exploratory development programs; develop specific proposals for such programs;
- (3) Develop, manage, and execute the plans for assigned areas of the 6.2 program, making use of the best available technical capability both from within and without the Navy to ensure effective performance on assigned programs;
- (4) Work in cooperation with ONT, the SYSCOMs, the Laboratories and R&D Centers to promote technology transition of mature projects into higher categories of R&D.

8. DON Exploratory Development Program Investment Strategy. The 6.2 Investment Strategy shall be formulated to define overall program objectives and management policies which shall:

- a. Determine the manner in which the 6.2 program will support the war-fighting objectives of the Maritime Strategy and respond to higher-level guidance;
- b. Assign program priorities at the mission and major technology levels;

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- c. Allocate funding to mission areas;
- d. Identify and specify policies for those critical technology areas and initiatives needing special emphasis;
- e. Integrate the individual Mission Area Strategies into a cohesive DON 6.2 program whose objectives and products can be directly related to war-fighting capabilities.

9. Mission Area Strategies. The Mission Area Strategies establish the DON 6.2 program objectives for each mission area in terms of the operational impact of the planned technology program on the warfighting capabilities of the Navy and Marine Corps. The format for the Mission Area Strategies is provided in enclosure (1). Provided in enclosure (2) is a listing of Naval Warfare Mission Areas and Corresponding 6.2 Program Mission Areas.

a. These strategies shall:

- (1) Provide program goals and guidance for the execution program planners and performers;
- (2) Define the technology thrusts required to achieve the mission-area objectives;
- (3) Provide the investment strategies for each mission area in terms of these technology thrusts;
- (4) Set priorities for the technology thrusts;
- (5) Define the block program objectives supporting the technology thrusts;
- (6) Provide a vehicle for describing the program.

b. The Mission Area Strategies shall also identify:

- (1) Mission-area technology needs and opportunities;
- (2) Threat drivers;
- (3) System deficiencies that may prevent the Navy from adequately countering threats or achieving the objectives of the Maritime Strategy;
- (4) Programmatic drivers such as high-level guidance and technology needs of development programs which drive priorities and schedules.

10. Mission Area Definitions. 6.2 Program Mission Area definitions are derived from those given in reference (d). Major platform and technology application areas are also defined as mission areas (enclosure (2)).

11. Program Structure. The 6.2 program shall be structured along mission-area lines. Funding shall be provided by program elements which approximate

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as closely as possible the mission areas. (The principal exception is Laboratory Independent Exploratory Development, discussed below in paragraph 17.) Similar, or closely related, mission areas shall be funded under the same program element. Each mission area is subdivided by the technology thrusts needed to meet its objectives. The technology thrusts shall be supported by one or more technical projects, combinations of which are contained in a block program. A project shall address one, and only one, technical thrust. At the Claimant level, projects generally will be further subdivided into tasks. A comprehensive set of Exploratory Development definitions is provided in enclosure (3).

12. Block Programming. ASN(RE&S) directed in reference (e) that, commencing in FY 1986, direct laboratory funding of the Exploratory Development Program should be provided to the greatest extent practicable, consistent with naval needs, program goals and investment strategies. This action was taken in response to SECNAV's goal to remove acquisition program management layers in favor of direct lines of communication and direct accountability. Direct laboratory funding has been implemented by Block Funding to Lead Laboratories with accountability through the Technical Directors of those Laboratories (reference (f)). Specific objectives of Block Funding are to:

- a. Streamline the 6.2 program management structure and thus simplify and improve coordination between headquarters and performers;
- b. Minimize resources and time consumed by program reporting, review, and approval processes;
- c. Improve program responsiveness by instituting a management-by-objectives policy at the headquarters level and minimizing headquarters involvement in execution management;
- d. Reduce program fragmentation and thereby attain improved productivity, relevance, quality, and allocation of resources, by structuring the major portion of the 6.2 program into well-defined, substantial units identified with major technical areas addressing enunciated naval needs and/or emerging, high-payoff technological opportunities;
- e. Promote management efficiency and flexibility by assigning to Navy Laboratories/R&D Centers the planning, budgeting, and execution of programs consistent both with the product and mission responsibilities of the Laboratories and with the mission-area objectives of the DON Exploratory Development program;
- f. Increase the collective effectiveness of the Navy Laboratory system by promoting cooperation and coordination among Navy Laboratories and minimizing the necessity for duplicative in-house facilities and expertise;
- g. Clarify and simplify lines of both fiscal and performance accountability.

13. Block Program Guidance. ONT will provide on an annual basis, detailed guidance for the preparation and submission of 6.2 Block Program Plans. This guidance will:

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- a. Assign responsibility for block management to specific Claimants;
- b. Allocate funds to blocks and projects for both Execution and POM years, (subject to revision as funding availability and other circumstances change);
- c. Update format and content specifications of the plans;
- d. Specify thresholds and conditions for reprogramming;
- e. Provide specific program direction where required;
- f. Identify protected areas of the program;
- g. Provide the planning, review and approval procedures, and schedule.

14. Block Program Plan. A Block Program Plan shall be submitted by each Claimant for each assigned block program. This plan describes the program to be executed for the Execution year and POM years. In addition to plans, these documents will contain sufficient technical information to allow them to serve as the consolidated source for the status, technical content, and products of the program. The technical information shall be adequate to determine when and where to transition the technologies and to identify gaps in the technology program. The general format and content of the Block Plan is provided in enclosure (4).

15. Reprogramming Authority. Claimants are delegated below-threshold-reprogramming (BTR) authority at the project level. For purposes of Block Plan preparation and submission, the fiscal thresholds and conditions for BTR are provided to Claimants in the annual Block Program Guidance. Reprogramming authority applicable during execution of the program is provided to Claimants with Execution Guidance. Above-threshold reprogrammings require approval of ONT through submission of a Program Change Recommendation (PCR). The PCR format is provided in enclosure (5).

16. Block Program Reporting Requirements. For purposes of providing necessary reports on the conduct of the 6.2 Block Programs, Claimants shall submit the reports shown in subsections a, b, and c below:

a. Task Summaries. Task Summaries provide data in a format for use in maintaining an updated computerized data base at ONT. Task Summaries shall be updated on an annual basis by Claimants and submitted to coincide approximately with submission of the Block Plans. Details of input requirements and format are provided in enclosure (6) and will be updated annually in the Block Program guidance.

b. Monthly Block Funding Reports. The monthly reports fall under the category of financial reports that are needed to track commitments, obligations and expenditures of 6.2 funds. The reports shall be submitted in a format similar to that of NAVCOMPT Form 2193. A sample of the form currently in use is provided as enclosure (7).

c. Block Quarterly Reports. Quarterly reports serve the purpose of highlighting Laboratory/R&D Center progress vs. milestones for the previous quarter as well as to elicit statements of problems encountered or concerns with the program. In addition, the reports shall provide accomplishments and funding information. The Block Quarterly Report format and guidance for preparation is provided in enclosure (8). Updates will be provided as necessary.

d. The 6.2 Accomplishments Report. This report shall be published annually by ONT. Inputs on accomplishments are solicited immediately following the end of the fiscal year from Laboratories, R&D Centers and other Claimants.

17. Independent Exploratory Development (IED) Program. The IED program is funded under a specific program element in the Exploratory Development program. The principal objective of the IED program shall be to provide the Technical Directors of the Navy R&D Centers with the financial means to support work judged by the Technical Directors to be important or promising in accomplishment of assigned missions. Technical Directors shall be given wide latitude in the use of IED funds to enable these same Directors to perform innovative, promising work without the procedure of formal and prior approval which might delay normal funding authorization. Although the Technical Directors shall place emphasis on exploratory development efforts for IED funds, they are not precluded from expending these funds for applied research, component development, prototype development, concept studies, and compilation of research done elsewhere. IED funds will not be used to make up deficiencies in other programs, nor for contracts, unless the latter support the basic goals of the IED program. If a task begun under IED leads to continued large efforts, it should be transferred to the regular RDT&E-sponsored program at the appropriate time and supported through the normal budget cycle. Normally no task should be supported under IED funding for a period of more than three years.

18. ONT Planning, Programming and Budgeting System (PPBS) Schedule. The 6.2 PPBS integrates the planning, programming and budgeting processes. The process shall be carried out on an annual basis with each quarter of the Fiscal Year emphasizing a distinct portion of the process, as follows:

a. First Quarter: Accountability. ONT management reviews and assesses the previous and current years' programs. Briefings are provided by the Claimant Tech Base and Block Program managers and such additional presenters as they deem appropriate.

b. Second Quarter: Strategic Planning. The Investment and Mission Area Strategies are developed by ONT. The 6.2 POM is completed and DON POM requirements satisfied.

c. Third Quarter: Execution Planning. The Block Program Guidance is issued and the Block Plans for the following fiscal year are developed.

d. Fourth Quarter: Block Program Plan Reviews, Modification, Approval, and Funding. During this quarter, Block Program plans are reviewed, adjusted and approved. Funding documents are promulgated by 30 September. Approval of

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the Block Plans will provide a Navy consensus on the following year's budget and the Block Plan fiscal information forms the basis for the Navy submittal for the President's Budget.

19. Program Guidance and Requirements Definition. The 6.2 program will derive guidance and requirements from the Maritime Strategy, Summary Warfare Appraisal and other Navy PPBS documentation and decisions, Master plans, and RDT&E road maps. The program will also be guided by technological and transition opportunities. The program will be responsive to formal OPNAV guidance and requirements statements from the Navy Systems Commands.

a. OP-098 Technology Program Analysis Memorandum (TPAM). This document will be provided to ONT during the first quarter of each fiscal year. It will consolidate technology requirements from Defense Guidance, OPNAV Warfare Appraisals, CINCS reports, and other sources for use during the POM development. It serves as a source of ONT planning guidance.

b. OPNAV Guidance to the Tech Base. This annual memorandum, provided in the second quarter of the current fiscal year, identifies the highest-priority Navy technology needs.

c. SYSCOM Technology Needs. The SYSCOMs should provide to ONT, in the first quarter of the current fiscal year, a statement of technology needs for use as planning information.

d. SYSCOM Program Recommendations. The SYSCOMs should, in the second quarter of the current fiscal year, provide to ONT specific technology program recommendations to be considered for incorporation into the Block Program Guidance.

20. Program Review. Exploratory Development Program reviews are described as follows. Enclosure (9) contains additional details.

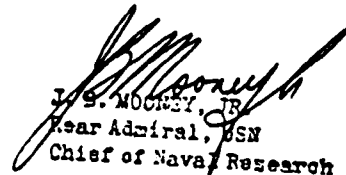
a. Block Program Review. As part of the assessment process, individual block programs will be reviewed by ONT during the first quarter of the fiscal year. SYSCOM representatives and other interested parties will be invited to participate in these reviews. Briefings and documentation will be the responsibility of individual Claimant Tech Base Managers and Block Program managers, in response to guidance from ONT Technical Directorates.

b. Technical Reviews. These will constitute in-depth reviews by ONT staff of selected technical efforts. They will be scheduled on an as-needed basis, principally during the third and fourth quarters of the current fiscal year. Briefings will be provided by the Claimants' technical staff. The Navy SYSCOMs and other appropriate headquarters organizations may request ONT to arrange additional reviews to meet their special needs.

c. Investment Strategy Reviews. These will consist of reviews of the overall Investment Strategy and the Mission Area Strategies. The review documentation and briefs will be provided by ONT. The CNR will review and

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approve these strategies during the third quarter of the current fiscal year. Subsequent to CNR approval, but still in the third quarter, the Strategies will be reviewed by OP-098 for response to guidance and stated requirements. SECNAV offices will review on an as-requested basis.


J. S. MOONEY, JR.
Rear Admiral, USN
Chief of Naval Research

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(continued on page 12)

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DIRECTOR, OFFICE OF NAVAL TECHNOLOGY



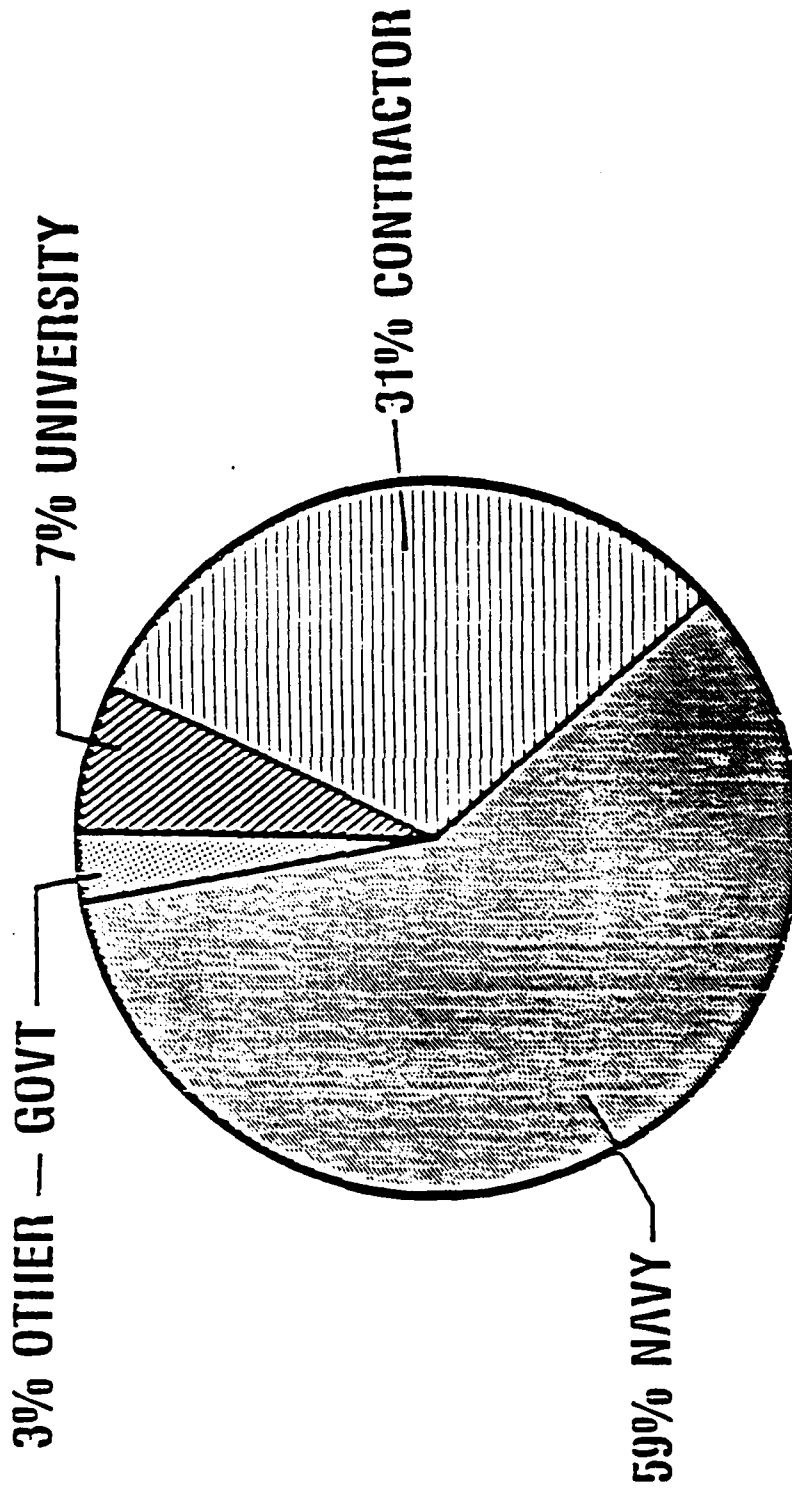
ONT MISSION

THE OFFICE OF NAVAL TECHNOLOGY WAS
CREATED ON
OCTOBER 1, 1980 BY SECNAV

“ ...TO STRENGTHEN THE COORDINATION AND
MANAGEMENT OF THE DON EXPLORATORY
DEVELOPMENT (6.2) PROGRAM ... TO PROVIDE
FOR A MORE CLEARLY DEFINED PROCESS OF
PLANNING, EXECUTION, AND TRANSITION OF
PROGRAMS WITHIN THE TECHNOLOGY BASE
AND INTO ADVANCED DEVELOPMENT...”



HOW DON 6.2 IS SPENT



\$435 MILLION DISTRIBUTION IN FY 1987



EXAMPLES OF JOINT SERVICE INVOLVEMENT

<u>TECHNOLOGY/PROGRAM</u>	<u>USAF</u>	<u>USA</u>
• SOLID FUEL RAMJET	X	
• LOW OBSERVABLES	X	
• ADVANCED FIGHTER	X	
• INTEGRATED HIGH PERFORMANCE TURBINE ENGINE TECHNOLOGY	X	X
• CLOSED LOOP ENERGY EFFICIENT AIRCRAFT ENVIRONMENTAL CONTROL SYSTEM	X	
• UNMANNED AIR VEHICLES	X	X
• BI-STATIC RADAR	X	
• SHAD	X	
• EIF SATCOM ENHANCEMENT	X	
• VHSIC COMMUNICATIONS	X	
• EIF SATCOM A/C ANTENNA	X	
• A/C NAVIGATION SYSTEM	X	
• CHEMICAL, BIOLOGICAL WARFARE DEFENSE		X
• AIRCRAFT EXPENDABLE DECOYS	X	X
• GROUND/SURFACE OBSCURANTS		X
• SPACE BASED RADAR	X	



EXAMPLES OF TRI-SERVICE INVOLVEMENT

- LASER EYE PROTECTION
- COMBAT CASUALTY CARE
- CHEMICAL, BIOLOGICAL, RADIOLOGICAL WARFARE
- ELECTRONIC WARFARE*
- FIBER OPTIC CONTROL SYSTEM INTEGRATION
- AIRBORNE DISPLAY
- CTOL, V/STOL, ROTARY WING
- C³
- AIRCRAFT INFORMATION TRANSFER
- JOB PERFORMANCE MEASUREMENT
- POWER TUBE MANUFACTURING
- ARTIFICIAL INTELLIGENCE
- EXPLOSIVE ORDNANCE DISPOSAL (COORDINATED)
- EXPLOSIVES (COORDINATED)
- SIGNAL PROCESSING**
- IMPROVED NUCLEAR DEVICES COUNTERMEASURES (COORDINATED)
- SENSOR AND DATA FUSION***
- TRI-SERVICE JOINT DIRECTORS OF LABORATORIES COOPERATIVE EW PLANNING
- ... TRI-SERVICE JOINT DIRECTORS OF LABORATORIES SUBPANEL ON SIGNAL PROCESSING
- ... TRI-SERVICE JOINT DIRECTORS OF LABORATORIES SUBPANEL ON DATA FUSION



OCNR PARTICIPATION IN COORDINATION GROUPS

MATERIALS:	COMMITTEE ON MATERIALS (WHITE HOUSE) NATIONAL MATERIALS ADVISORY BOARD JDL PANEL
ELECTRON DEVICES:	ADVISORY GROUP ON ELECTRON DEVICES
COMMAND & CONTROL:	JDL PANEL
BIO MEDICAL:	ASUREM (ARMED SERVICES BIO-MED RESEARCH EVALUATION & MANAGEMENT COMMITTEE)
DW/CW:	ARMY LEAD — NAVY LIAISON OFFICER
EW:	JDL PANEL
POWER (NON-NUCLEAR):	INTER AGENCY POWER GROUP
NUCLEAR POWER:	NAVY REPRESENTATION TO DOE
MISSILE PROPULSION:	JANNAF (JOINT ARMY, NAVY, NASA, AF)
SIGNAL PROCESSING:	JDL PANEL
TICP:	ADMINISTERING OFFICE FOR NAVY

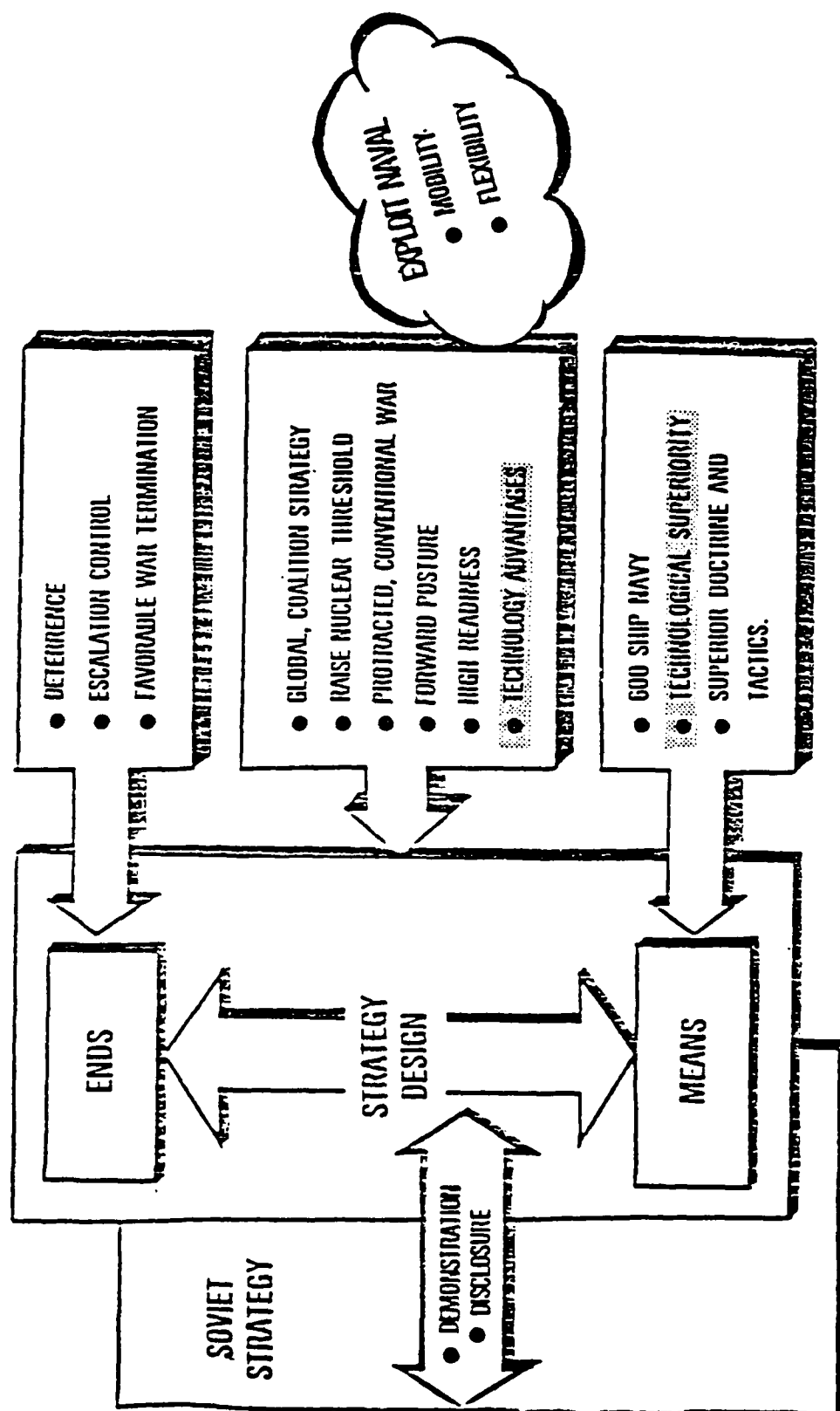
6.2 PROGRAM MANAGEMENT OBJECTIVES



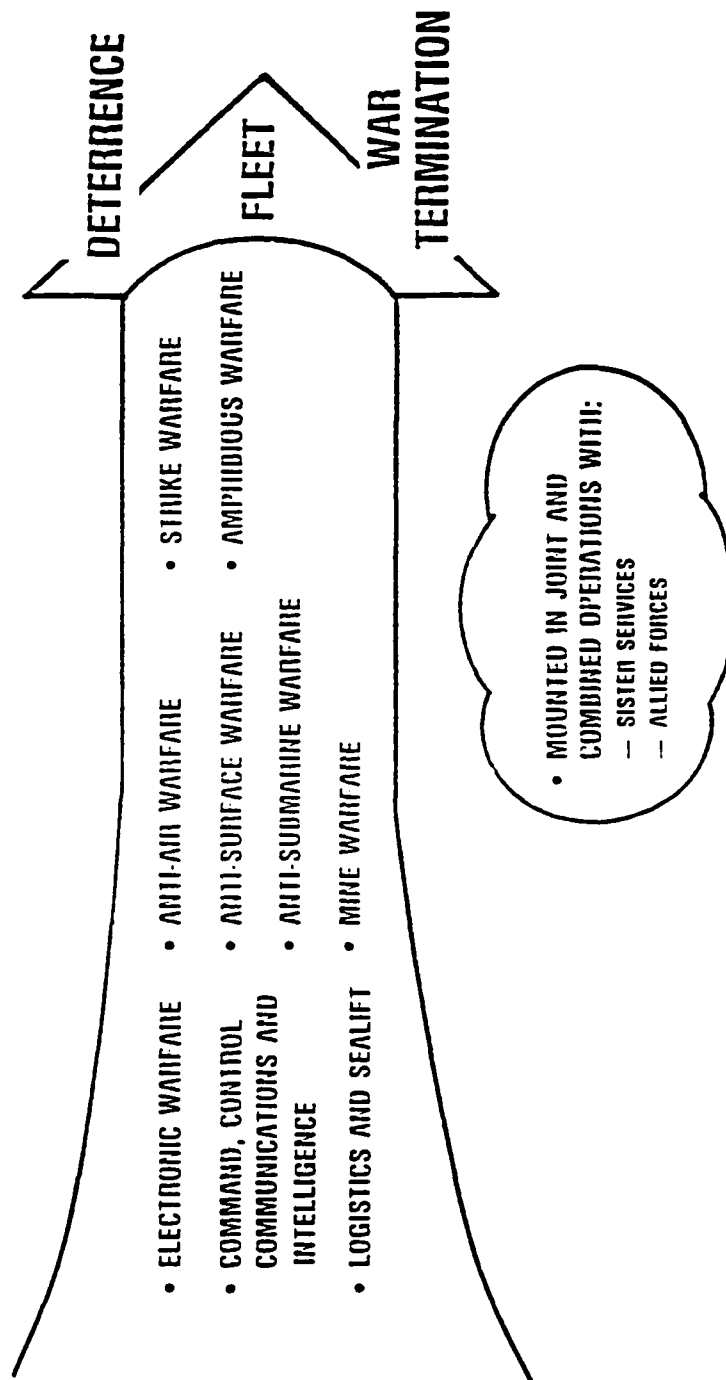
- **ESTABLISH A 6.2 PROGRAM FOUNDED ON AND MANAGED ACCORDING TO OPERATIONAL WORTH OF ITS DEVELOPMENT PROJECTS AND WHICH SUPPORTS THE NAVY MARITIME STRATEGY AND ITS WARFIGHTING OBJECTIVES**
- **HARMONIZE PROGRAM WITH NAVY CURRENT AND ANTICIPATED RDA THRUSTS**
- **ACHIEVE INTEGRATION OF OBJECTIVES WITH THOSE OF HIGHER CATEGORIES OF RDT&E**



MARITIME STRATEGY

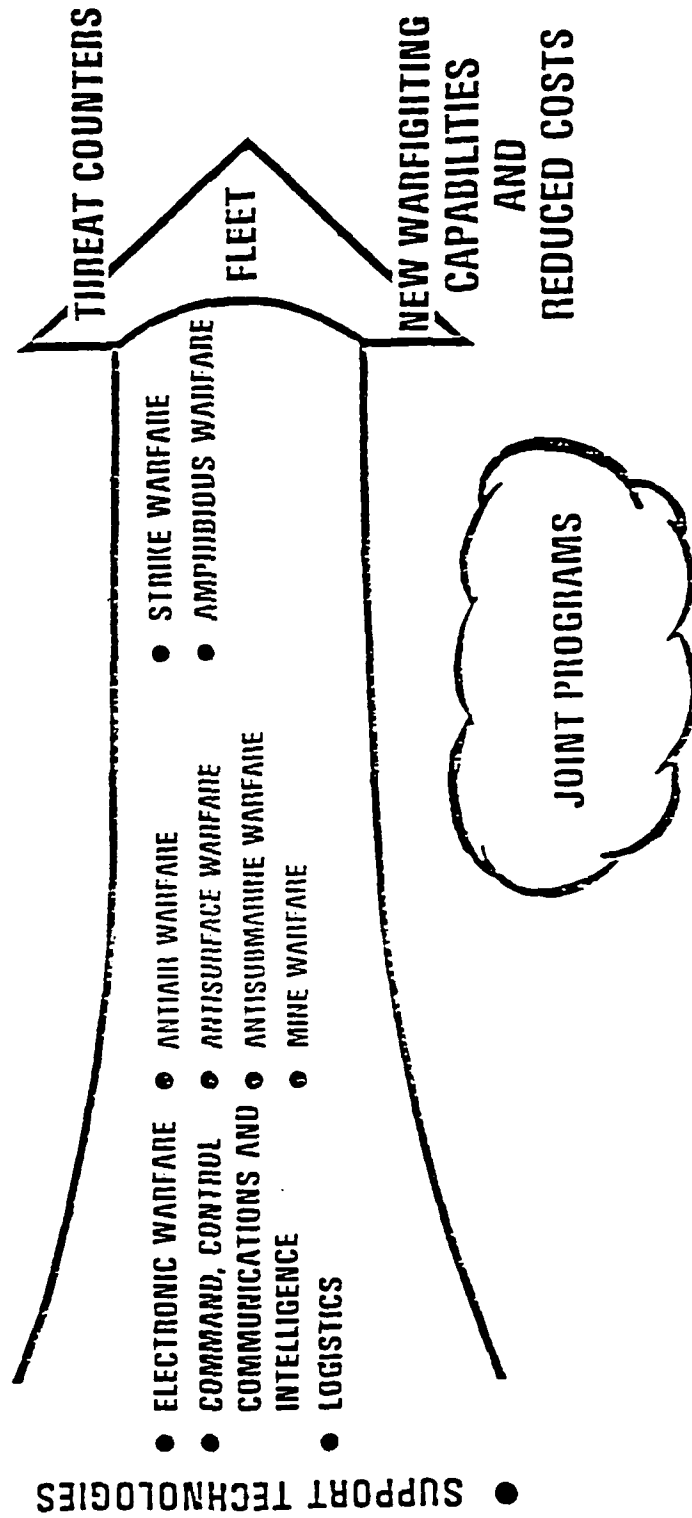


NAVAL STRATEGY **INTEGRATES ALL NAVAL WARFARE MISSIONS**





6.2 INVESTMENT STRATEGY INTEGRATES ALL NAVAL WARFARE TECHNOLOGIES





ENABLING TECHNOLOGIES

EXAMPLES

- GaAs MM — WAVES DEVICES
- IRFPA
- VIISIC
- MMIC
- FIBER OPTICS
- AI
- MATERIALS
- DIRECTED ENERGY

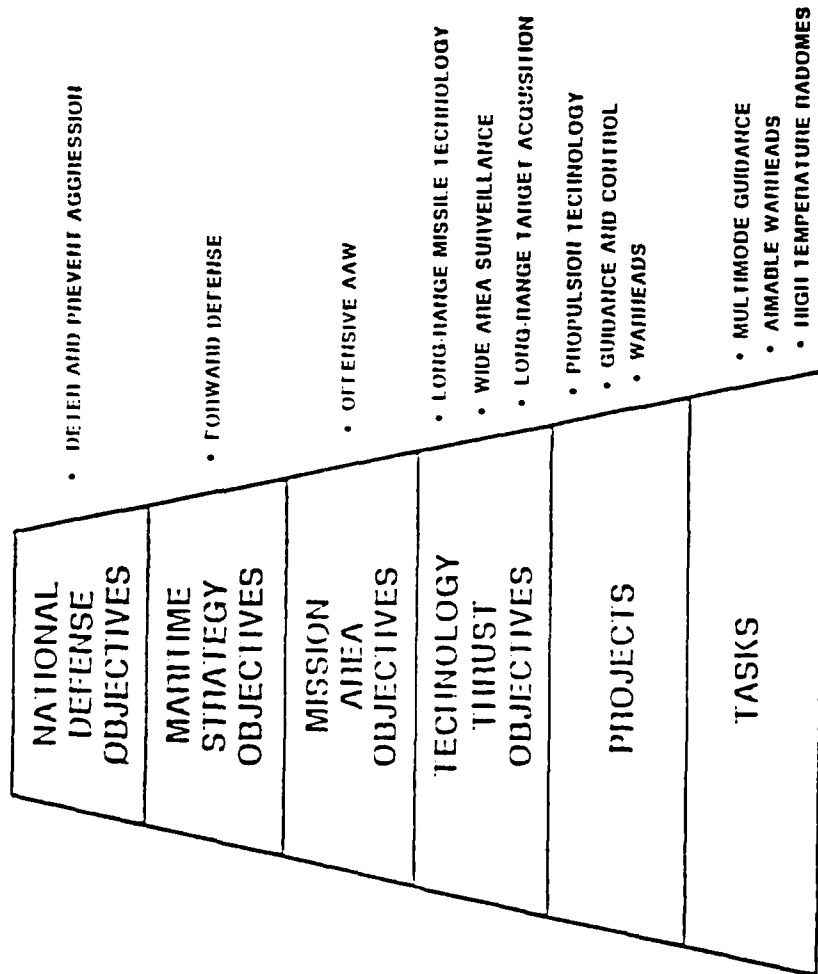


NEW/IMPROVED CAPABILITIES AND PERFORMANCE

- ADVERSE WEATHER OPERATION
- LETHALITY/FORCE MULTIPLICATION
 - TARGET RECOGNITION
 - AIMPOINT SELECTION
 - AUTONOMOUS OPERATION
- SURVIVABILITY
 - PASSIVE/LPI SENSORS
 - LOW OBSERVABLES
 - AUTONOMOUS OPERATION
- LAND ATTACK
- ANTI-AIR
 - SELF DEFENSE
 - SATURATION RAID DEFENSE
 - SEA SKIMMER DEFENSE



DON 6.2 PROGRAM STRUCTURE



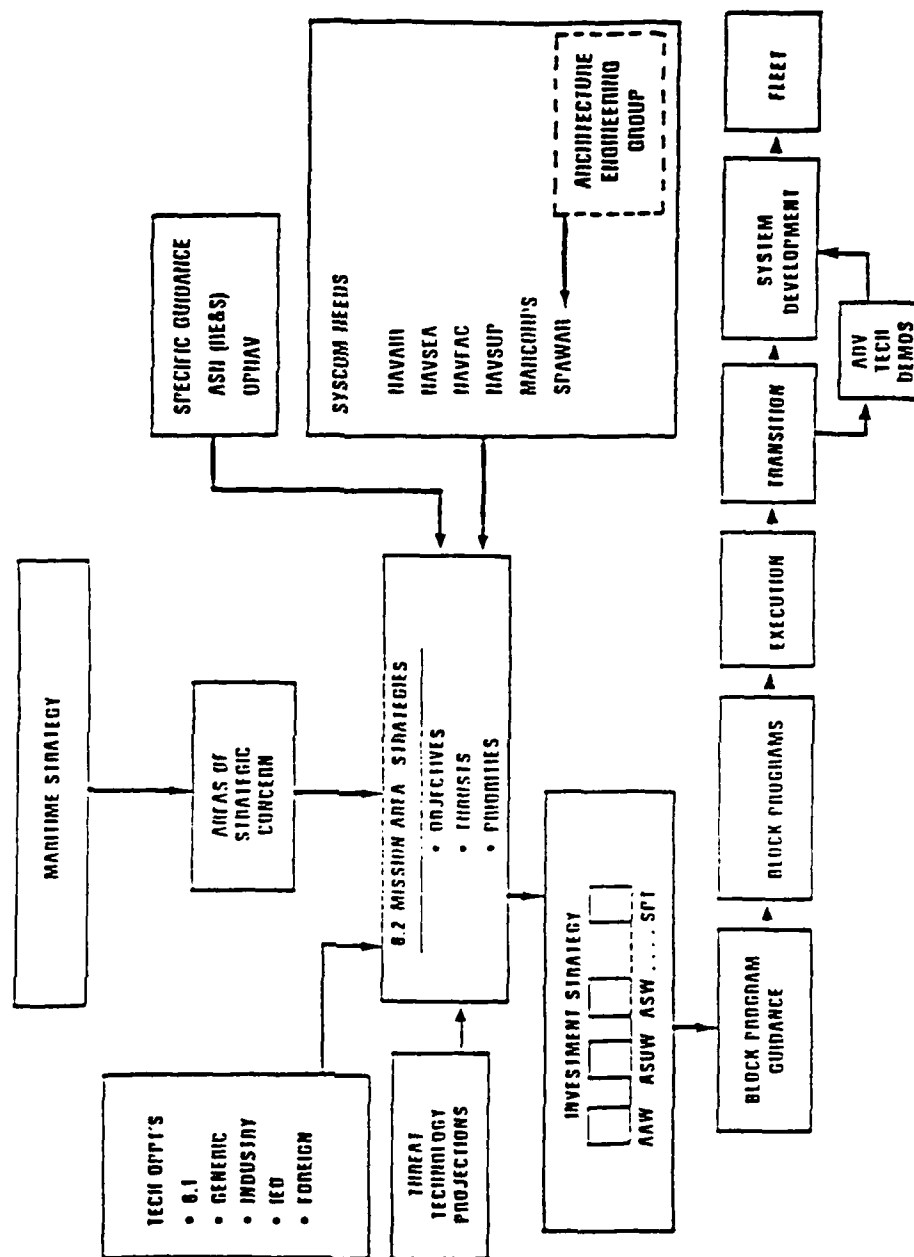
The diagram illustrates the Joint Maritime Strategy Development Process, showing the flow of information and decision-making across various maritime strategy components. The process is organized into several interconnected blocks and boxes, with arrows indicating the direction of flow and interaction.

Key Components and Flow:

- Inputs and Initial Processing:**
 - THE MARITIME STRATEGY US** (represented by a stack of boxes) and **GLOBAL WARFARE** (represented by a stack of boxes) feed into **JLCS, JUMC & OPNAV STRATEGY INPUTS** (represented by a cloud shape).
 - JLCS, JUMC & OPNAV STRATEGY INPUTS** feeds into **POM STRATEGY CPAM** (represented by a box with a dashed line).
- Core Decision and Analysis Blocks:**
 - POM STRATEGY CPAM** feeds into **CPAM'S APPRAISALS AND PROGRAM DECISION PROCESS 095/090/02/03/05 ...** (represented by a box).
 - CPAM'S APPRAISALS AND PROGRAM DECISION PROCESS** interacts with **MISSION AREA STRATEGIES OMT** (represented by a box) and **TECHNOLOGY AREAS OF STRATEGIC CONCERN 095/098/091** (represented by a box).
- Guidance and Program Development:**
 - MISSION AREA STRATEGIES OMT** and **TECHNOLOGY AREAS OF STRATEGIC CONCERN** feed into **BLOCK PROGRAM GUIDANCE OMT** (represented by a box).
 - BLOCK PROGRAM GUIDANCE OMT** feeds into **BLOCK PROGRAMS LABS/INDUSTRY/UNIV'S** (represented by a box).
 - BLOCK PROGRAMS LABS/INDUSTRY/UNIV'S** feeds into **AID PROGRAMS 098** (represented by a box).
- Final Output and Planning:**
 - AID PROGRAMS 098** feeds into **FY 09 PLANNING CYCLE** (represented by a box).
 - FY 09 PLANNING CYCLE** feeds into **WARFARE CAPABILITIES** (represented by a box).
 - WARFARE CAPABILITIES** feeds into **TECH-BASE OPPORTUNITIES OCHH** (represented by a box).
 - TECH-BASE OPPORTUNITIES OCHH** feeds into **POM WARFARE** (represented by a box).
 - POM WARFARE** feeds into **THE MARITIME STRATEGY US** and **GLOBAL WARFARE**, completing the cycle.
- Additional Interactions:**
 - TECHNOLOGY OPPORTUNITIES LABS/INDUSTRY/UNIV'S** (represented by a box) feeds into **MISSION AREA STRATEGIES OMT**.
 - TECHNOLOGY AREAS OF STRATEGIC CONCERN** also feeds into **TECHNOLOGY OPPORTUNITIES LABS/INDUSTRY/UNIV'S**.

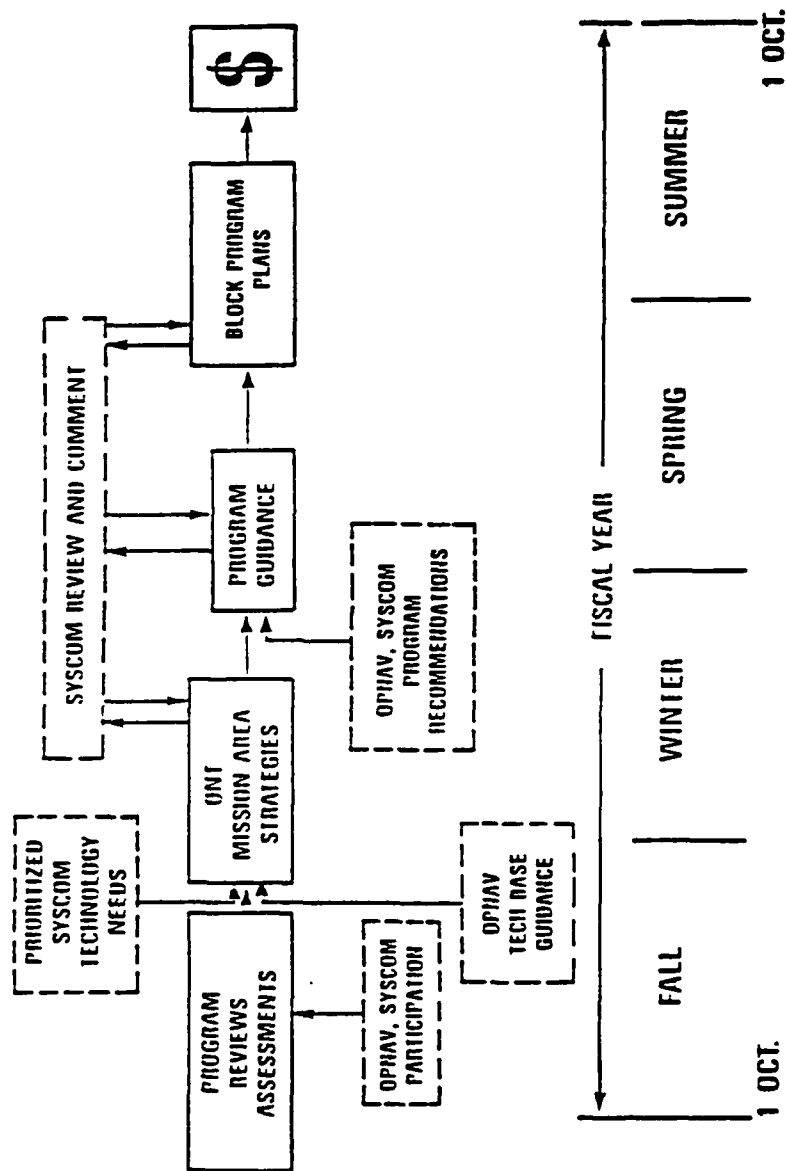


TECH BASE GUIDANCE DEVELOPMENT





6.2 PLANNING CYCLE





PRIORITY BUILDING BLOCKS

- MARITIME STRATEGY AREAS OF STRATEGIC CONCERN
- NAVY UNIQUE REQUIREMENTS
- TECHNOLOGY OPPORTUNITIES OFFERING A DECISIVE TACTICAL ADVANTAGE AND/OR LARGE REDUCTIONS IN LIFE CYCLE COSTS
- TRANSITION OPPORTUNITIES
- CREDIBLE EXECUTABLE EXPLORATORY DEVELOPMENT PROGRAMS WITH CLEAR PATH TO TRANSITION



6.2 EXPLORATORY DEVELOPMENT PROGRAM

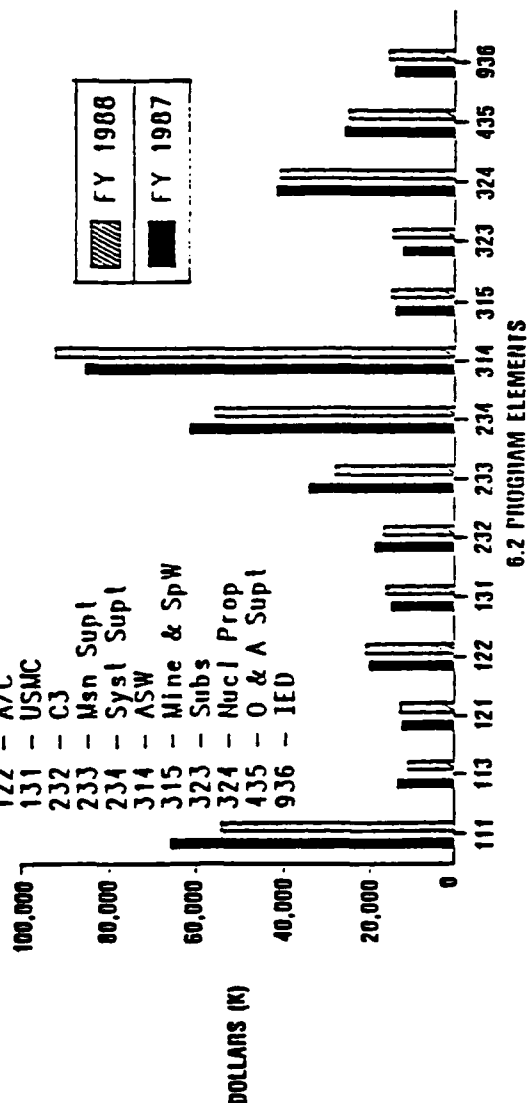
FISCAL 87-88
6.2 FUNDING

FEB 88

SUPPORT TECHNOLOGIES
COMMAND, CONTROL, COMMUNICATIONS TECHNOLOGIES
MISSION SUPPORT TECHNOLOGIES
(NAVIGATION; PERSONNEL & TRAINING;
BIOMEDICAL; LOGISTICS; CHEMICAL/
BIOLOGICAL/RADIOLOGICAL DEFENSE)
SYSTEMS SUPPORT TECHNOLOGIES
(ELECTRONIC DEVICES; MATERIALS; HUMAN
FACTORS; GENERAL OCEANOGRAPHY; COMPUTER
HARDWARE, SOFTWARE, AND ARCHITECTURE;
ARTIFICIAL INTELLIGENCE)

**ANTISUBMARINE WARFARE
AND UNDERSEA
TECHNOLOGY**
ANTISUBMARINE WARFARE
SUBMARINE TECHNOLOGY
SPECIAL WARFARE
MINE WARFARE
NUCLEAR PROPULSION

**ANTI-AIR / ANTISURFACE
WARFARE AND
SURFACE / AEROSPACE
TECHNOLOGY**
ANTI-AIR WARFARE
ANTISURFACE WARFARE
ELECTRONIC WARFARE
AMPHIBIOUS WARFARE
SURFACE SHIP TECHNOLOGY
AIRCRAFT TECHNOLOGY





TODAY'S ENVIRONMENT

- SHRINKING REAL DOLLARS
- NEED TO INTEGRATE TECH BASE AND STRATEGIC PLANNING*
- SECDEF COMPETITIVE STRATEGIES
- SHIFT TOWARD INITIATIVE FUNDING -- CDI, ADI, BTI...
- THE ENVIRONMENT HAS CHANGED AND CONTINUES TO CHANGE RAPIDLY

*VCNO MEMORANDUM OF 9 JUNE 1986: STRATEGIC PLANNING AND THE
TECHNOLOGY BASE

Appendix D

AIR FORCE LONG-RANGE S&T PLANNING PROCESS

AIR FORCE LONG-RANGE S&T PLANNING PROCESS

The following document has recently been issued by the Air Force. It represents a complete long range plan for the total Air Force S&T program.

UNITED STATES AIR FORCE
HEADQUARTERS AIR FORCE SYSTEMS COMMAND

THE
AIR FORCE
SCIENCE & TECHNOLOGY
AND
DEVELOPMENT PLANNING
PROGRAM



DEPUTY CHIEF OF STAFF/TECHNOLOGY AND REQUIREMENTS PLANNING

JUNE 1988

Distribution authorized to U.S. Government agencies and their contractors (Administration) May 88.
Other requests for this document shall be referred to HQ AFSC/XIX Andrews AFB DC 20330-6000.

"Guided by Project Forecast II, a study identifying new technologies for improving future warfighting capabilities, the Air Force will continue an aggressive research and development program to ensure continued technological superiority over any adversary."

General Larry D. Welch
Chief of Staff, USAF



FOREWORD

The mission of Air Force Systems Command (AFSC) is to acquire weapon systems with superior warfighting capability for our users, the Air Force operational commanders and the CINCs. To this end, I have established three Command goals:

- (1) Meet the users' needs,
- (2) Maintain acquisition excellence; and
- (3) Enhance our technological superiority.

An innovative Science and Technology (S&T) Program, the cornerstone of our Nation's defense since World War II, is still the key to providing an affordable, qualitatively superior military force. Maintaining that necessary technological lead is becoming more difficult. Soviet technological advances are increasing as their investment in research and development continues to outpace ours. The challenge is to focus our valuable S&T resources into areas that can achieve the greatest increase in combat capability.

This pamphlet, built on the legacy of Project Forecast II, outlines our plan to meet the challenge in concert with changes in the threat, national policy, technological opportunity, and available program funding.

We have the right plan for our critical Air Force S&T resources. We will succeed in meeting the needs of our users and with the timely acquisition of technologically superior weapon systems.

BERNARD P. RANDOLPH, GENERAL, USAF
Commander
Air Force Systems Command

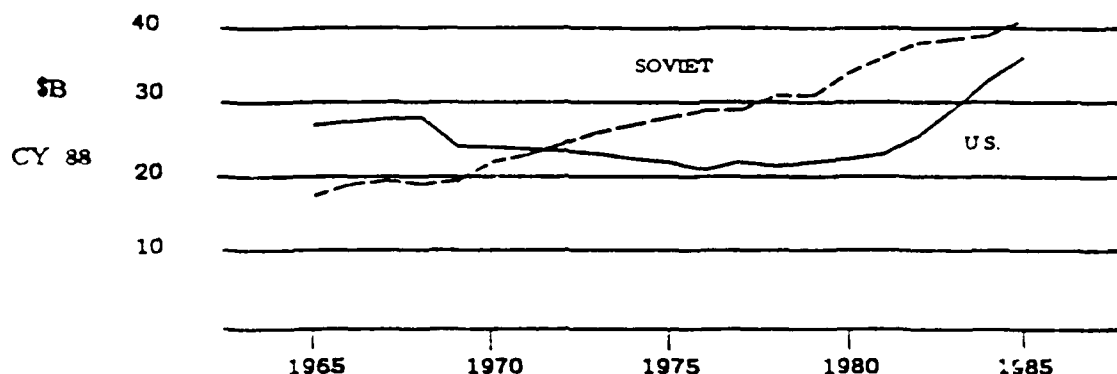
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THE TECHNOLOGICAL THREAT

The Soviet Union relentlessly pursues programs which challenge the US technological lead in qualitatively superior weapon systems. Between 1970 and 1985, aggregate Soviet RDT&E spending exceeded that of the US by \$63 billion. The technological momentum gained by the Soviets in the 1970's has been addressed by the sharp increase in RDT&E spending by the US in the 1980's. However, the impact of the US response will not be instantaneous and may not be sufficient to permanently reverse this disturbing trend.

U.S. vs SOVIET MILITARY RESEARCH, DEVELOPMENT, TEST & EVALUATION



Spending alone will not guarantee technological superiority. The Soviets also aggressively exploit Western technology to reduce the technology gap. As shown below, the US leads the USSR in 15 of 20 basic technology areas and is equal in the remaining 5 areas. The arrows depict the 11 areas where the Soviets are improving their relative standing. This pamphlet outlines the Air Force S&T investment strategy to regain, improve, and sustain a technologically superior force to defend the US and its allies.

1988 RELATIVE US/USSR STANDING IN 20 BASIC TECHNOLOGY AREAS

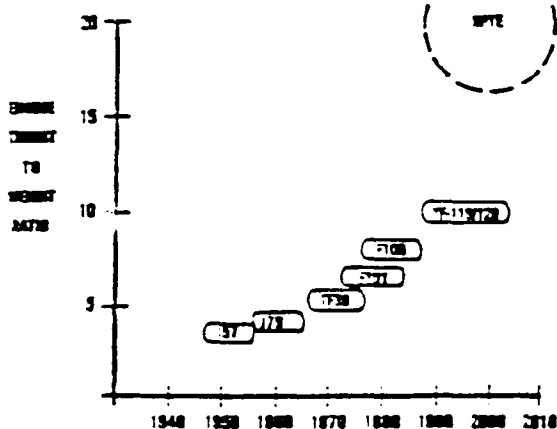
BASIC TECHNOLOGIES	US SUPERIOR	US/USSR EQUAL	USSR SUPERIOR
1. AERO/FLUID DYNAMICS	X		
2. COMPUTERS & SOFTWARE	X		
3. CONVENTIONAL WARHEADS		X ▶	
4. DIRECTED ENERGY		X ▶	
5. ELECTRO-OPTICAL SENSORS	X ▶		
6. GUIDANCE & NAVIGATION	X		
7. LIFE SCIENCES	X ▶		
8. MATERIALS	X ▶		
9. MICRO-ELECTRONIC MATERIALS & IC MANUFACTURING	X		
10. NUCLEAR WARHEADS		X	
11. OPTICS		X ▶	
12. POWER SOURCES		X	
13. PRODUCTION/MANUFACTURING	X ▶		
14. PROPULSION	X ▶		
15. RADAR SENSORS	X ▶		
16. ROBOTICS & MACHINE INTELLIGENCE	X		
17. SIGNAL PROCESSING	X		
18. SIGNATURE REDUCTION	X ▶		
19. SUBMARINE DETECTION	X ▶		
20. TELECOMMUNICATIONS	X		

Source: USDP&E

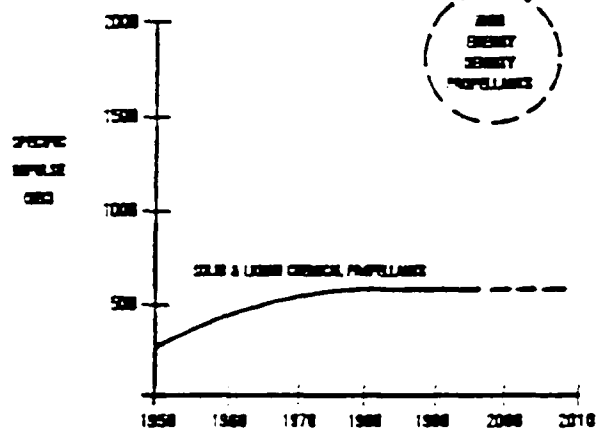
NEW TECHNOLOGIES TO MEET THE THREAT

To meet the challenge imposed by our adversaries, the US must aggressively develop revolutionary enabling technologies that will change the nature of warfighting. In the last 50 years, technological advances have accelerated military capabilities at a rate unprecedented in history. The US has been on the leading edge of this surge through a science and technology program that encouraged research and development and innovative employment concepts. The graphs below depict technology's steady advance in several areas and highlight important breakthrough opportunities. The High Performance Turbine Engine (HPTX), with a thrust-to-weight ratio double anything currently on the drawing boards, will revolutionize aircraft maneuverability, range, payload, and basing capabilities. The goals of High Energy Density Propellant (HEDP) research are a twofold increase in launch vehicle lift capability and a three to fivefold increase in upperstage orbit transfer capability. Advanced materials such as carbon/carbon and ceramic composites are key to the HPTX and high Mach flight vehicles. The tremendous processing speeds offered by photonic devices could revolutionize battle management and real time processing of on-board sensors. These advances are examples of the decisive role S&T can play in shaping the military capabilities of our future defense forces.

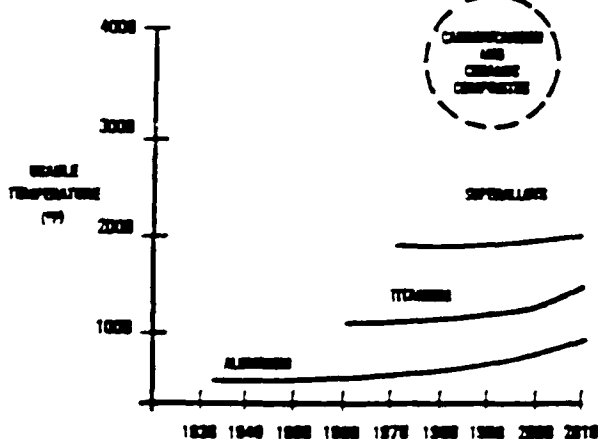
**BREAKTHROUGH OPPORTUNITY
TURBINE ENGINES**



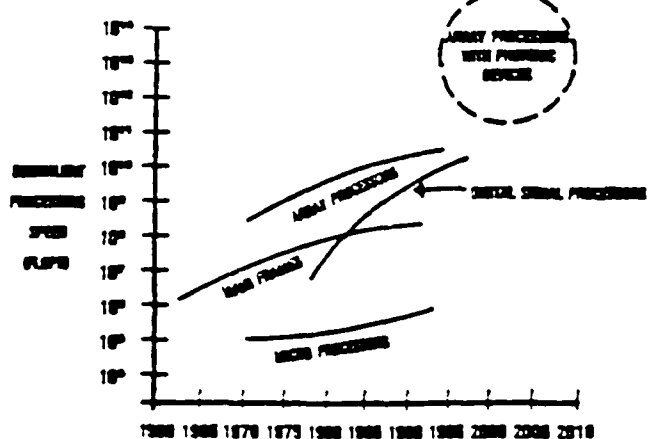
**BREAKTHROUGH OPPORTUNITY
PROPELLANTS**



**BREAKTHROUGH OPPORTUNITY
MATERIALS**



**BREAKTHROUGH OPPORTUNITY
COMPUTERS**



THE CHALLENGE OF TECHNOLOGY TRANSITION

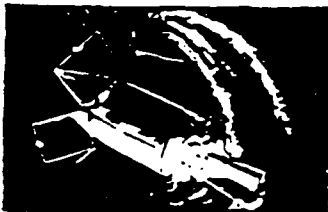
New weapon systems generally rely on technology developments which began 10 to 15 years ago in laboratories. This page depicts the lead time to develop, prove and transition several key technologies incorporated in today's most advanced systems. We are making the commitment to develop and transition the new breakthrough technologies critical to providing superior weapon systems for the future Air Force. Subsequent sections of this pamphlet outline our investment strategy for mission and technology areas.



B-1B Bomber



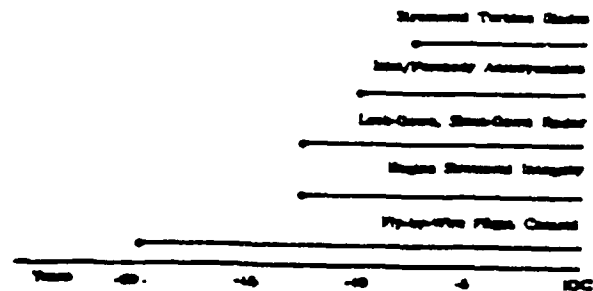
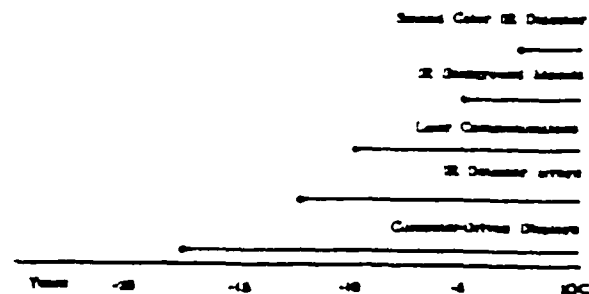
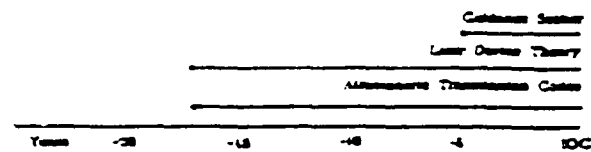
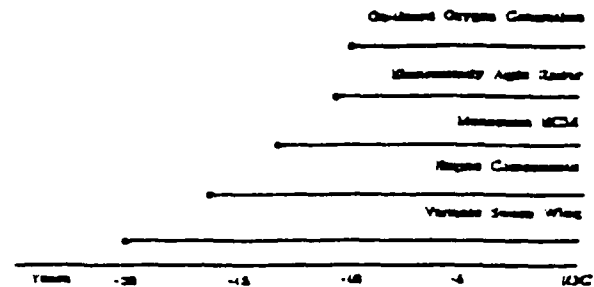
Laser Guided Bomb



DSP Satellite



F-15 Fighter



Project Forecast was initiated to identify future high leverage technologies and system concept options - a status report follows.



A STATUS REPORT

Project FORECAST II, the means to focus investment in new technologies in the Air Force S&T Program, has been implemented. Since last year, the Air Force has increased investment in PFTI-related technologies by 14 percent to \$623 million. In FY 87, Air Force laboratories began developing five high-leverage PFTI initiatives unconstrained by funding and limited only by the ability to advance the technology. The initiatives are listed below along with the key accomplishments demonstrated during the past year.

TECHNOLOGY-LIMITED PROGRAMS

PHOTONICS

- o Established Air Force Photonics Center at the Rome Air Development Center
- o Developed cooperative program with academia and industry
- o Demonstrated optical logic elements, tunable optical sources, multiple wavelength local area networks for high speed computers

DIRECTED ENERGY TECHNOLOGY

- o Subsystems tested for vulnerability to high-power microwaves (HPM)
- o Developed frequency-tunable, gigawatt-class HPM sources
- o Demonstrated subcooled solid-state laser phased arrays
- o Demonstrated high power chemical oxygen-iodine laser (COIL)
- o Feasibility established for tactical application of directed energy weapons

HIGH TEMPERATURE MATERIALS

- o Demonstrated high temperature capability of titanium aluminide
- o Fabricated titanium-aluminide ceramic composites
- o Developed silicon carbide fiber reinforcement for 2500 deg F service
- o Basis established for next generation turbine engine materials

NON-LINEAR OPTICS

- o Completed optical parametric amplifier experiment
- o Demonstrated interferometric measurement of nonlinear optical image quality
- o Developed nonlinear optical imaging technique to remove distortion
- o Discovered competing nonlinear optical process
- o Potential established for light-weight precision optical systems

HIGH-ENERGY DENSITY PROPELLANTS

- o Developed new computer techniques that support theory extrapolations
- o Discovered new rare-gas compounds
- o Prepared world's first gas-phase metal borohydride
- o Identified new energetic mono-propellants



A STATUS REPORT

Last year Air Force laboratories also increased investment in the six PFII initiatives listed below. The emphasis placed on these technologies has already begun to yield high payoffs, as seen by the major accomplishments shown in each area.

INCREASED INVESTMENT PROGRAMS

HIGH PERFORMANCE TURBINE ENGINE (HPTE)

- o Demonstrated structural integrity of high strength fiber reinforced, light weight compressor components
- o First HPTE technology demonstrator under test
- o Demonstrated metal matrix and graphite composite main structural components
- o Began development of 27 high performance engine components

SMART SKINS

- o Fabricated structural-conformal radar array
- o Developed self-calibrating 32-element array with digital beamforming
- o Investigated effects/advantages of antenna design on aircraft configuration

KNOWLEDGE BASED SYSTEMS

- o Established Artificial Intelligence Applications Center
- o Transitioned prototype mission planner to Tactical Air Command
- o Developed multiple knowledge-based test bed
- o Initiated large-scale software development testbed

BRILLIANT WEAPONS

- o Demonstrated brassboard laser radar sensor for "near zero" LoEP guidance
- o Collected infrared and millimeter wave signatures of tactical targets
- o Completed captive flight demonstration of advanced air-to-air seeker

ROBOTIC TELEPRESENCE

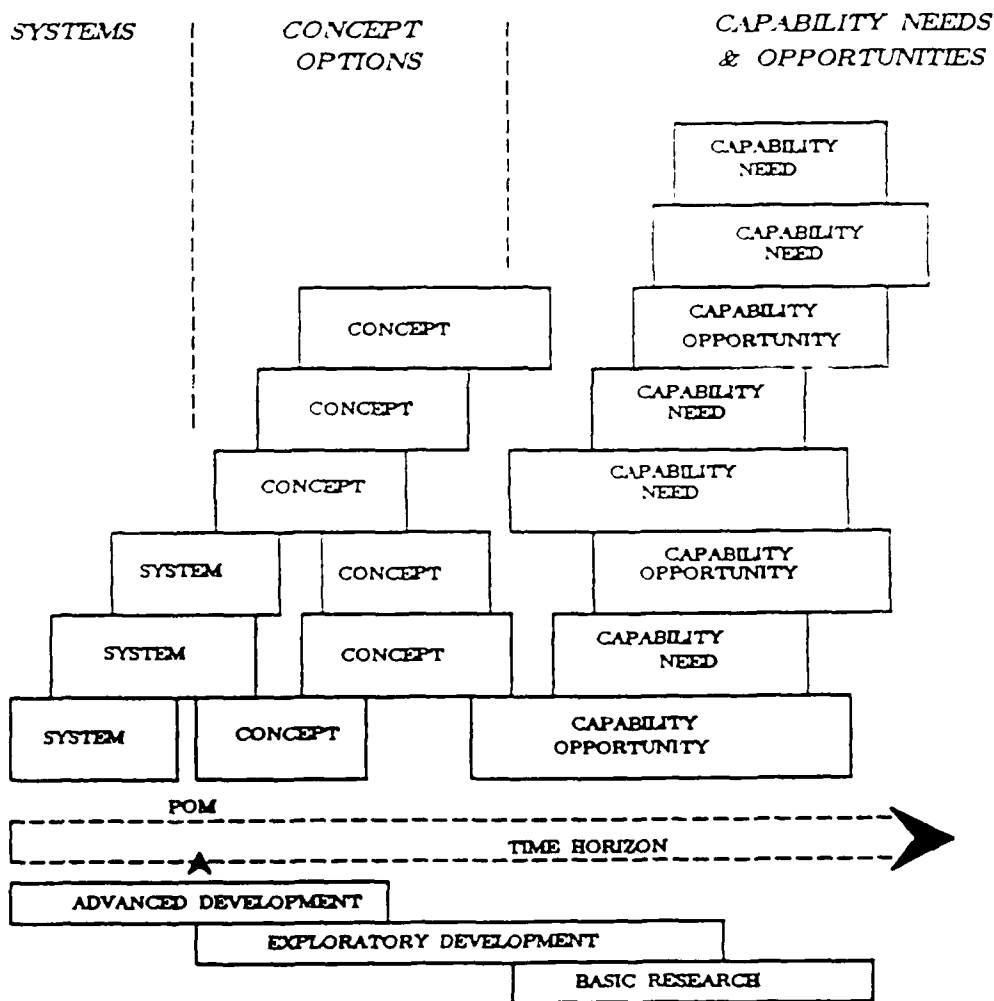
- o Procured two dextrous manipulators (mechanical hands) for evaluation
- o Began kinematic computer modeling of robot systems
- o Began exoskeleton development effort

SUPER COCKPIT

- o Developed night vision goggles with heads-up display (HUD)
- o Flight demonstration of eagle eye helmet (HUD in a helmet with head tracker)
- o Flight demonstration of head-stared forward-looking infrared (FLIR) sensors
- o Tested 3-D (projected) panoramic helmet display

AFSC LONG RANGE PLANNING PROCESS

Responding to the threat and the challenge of technology transition, AFSC instituted a long range planning process to focus Air Force S&T investments. Depicted below is a snapshot of this process and its three components - - deployed and developed systems, system concept options, and future capability needs and opportunities. Within the POM horizon, ADVANCED DEVELOPMENT efforts are oriented to generally support the limited number of system programs which have been approved for development by the corporate Air Force. S&T EXPLORATORY DEVELOPMENT efforts support a larger number of potential system concept options which will be evaluated for further system development beyond the POM years. Finally, today's BASIC RESEARCH investments establish the foundation needed for the far term to support a broad number of military capability needs and opportunities. Concept options and capability needs and opportunities are derived from both user pull and technology push. Therefore, they represent the "realm of the possible" to the users in the Air Force operational commands. Through the requirements process, the Air Force will assess, validate, and fund those system concepts that best satisfy the users' evolving needs in response to the threat.



The next section summarizes the results of this process for each of the Air Force mission areas.

MISSION AREA SUMMARIES

The Air Force conducts requirements planning in 10 mission areas:

Strategic Offense	Armament
Strategic Defense	Reconnaissance/Intelligence
Space	Electronic Combat
Mobility/Special Operations Forces	Command and Control
Tactical	Air Base Operability

Summaries of the 10 mission area plans appear on pages 10 - 19.

How to read the summaries:

I. Capability Needs

Each Mission Area Summary cites a list of capability needs provided by the Air Force using commands.

II. Systems & Systems Concepts

Systems listed under the *Current* column are either fielded, in production, or have a scheduled IOC in the near-term. System concepts listed under the *Next Generation* (IOC planned in the mid-term) and *Future* (IOC planned in the far-term) columns represent possible options available by applying maturing technologies to meet operational requirements. The using commands will select and advocate for funding only those options that best meet their needs. The system concepts are listed in the time frame they are scheduled to become operational.

III. Key Technologies




The key technologies are associated with the systems and system concepts listed above them in the same column. Technologies in the *Current* column have already been integrated in the systems fielded or nearing IOC, while those in the *Next Generation* and *Future* columns have acceptable risk but require maturation to enable the listed system concept options. These are not comprehensive lists of all Air Force pertinent S&T investments, but they do represent the essence of the S&T investment strategy.

STRATEGIC OFFENSE MISSION AREA SUMMARY

I. USER CAPABILITY NEEDS

- | | |
|--|---|
| 1. Locate/Strike Strategic Relocatable Targets | 5. Integrate Conventional Munitions |
| 2. Enhanced Aircraft Survivability | 6. Survivable ICBM Basing |
| 3. Strike Deeply Buried Targets | 7. ICBM Penetration of Layered Defenses |
| 4. Increased Aerial Refueling Capacity | |

II. SYSTEMS & SYSTEM CONCEPTS

Current	Next Generation	Future
		
Bombers		
B-1B B-52 G/H FB-111	B-2	Hypersonic Vehicle
ICBMs		
Minuteman II/III Peacekeeper (Silo)	Minuteman IV/V Peacekeeper (Rail) Small ICBM (Hard Mobile Launch)	ICBM Enhancements
Tankers		
KC-135 A/E/R KC-10		KC-X
Munitions		
SRAM Air Launched Cruise Missile MK 82/84 Gravity Bombs Harpoon Tact Rainbow HAVE NAP	SRAM II Conventional Cruise Missile Advanced Cruise Missile AMRAAM Earth Penetrating Weapon Hard Target Munition	Hypersonic Weapon Long-Range Conventional Cruise Missile

III. KEY TECHNOLOGIES

Radar Cross Section Reduction
Variable Sweep Wing
Cold Launch ICBM
Electronically Agile Radar
On-Board Oxygen Generation
Mobile Gravity Surveying

Radiation-Hardened Devices
Enhanced Chemical Propellants
Automatic Target Cuesing
Multi-Spectral, Multi-Mode Sensors
Multi-Source Data Processing
Display
Stealth
Re-entry Vehicle Signature Reduction

Hypersonic
Combined Cycle Propulsion
Ultra-High Speed Processing
High Energy Density Propellants
Super Cockpit
Superconducting INS
High Temperature, High Strength Materials
Fast Burn Propellants
Active Cooling
Hypersonic Escape

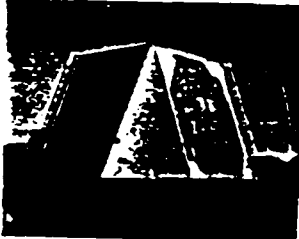
STRATEGIC DEFENSE MISSION AREA SUMMARY

I. USER CAPABILITY NEEDS

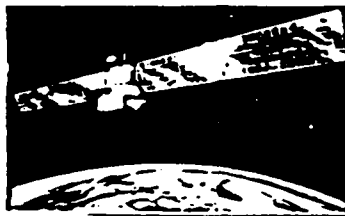
1. Ballistic Missile Tactical Warning/Attack Assessment Systems
2. Atmospheric and Space Surveillance Coverage and Track Coverage
3. Long-Range Intercept Capability
4. Interceptors
5. Capability to Protect U.S. Space Assets
6. Ground, Air, & Space Systems Protection

II. SYSTEMS & SYSTEM CONCEPTS

Current



Next Generation



Future



Ballistic Missile Defense

Satellite Early Warning System (SEWS)
BMEWS
PAVE PAWS
Nuclear Detonation Detection System

SEWS Follow-on
BMEWS Modification
PAVE PAWS Upgrade

Directed Energy Weapon
Kinetic Energy Weapon
Space Surveillance & Tracking System

Atmospheric Defense

North Warning System
Over the Horizon Backscatter Radar
F-15, F-16
AMRAAM
AWACS
SEEK IGLOO
DEW Line

Space-Based Radar
OTH-B Upgrades
F-15, F-16 Improvement
Improved AMRAAM
AWACS Block Improvements
Advanced Aerial Platform
(Aircraft or Airship)

Advanced OTH Radar
Long-Range Hypersonic Platform/
Munition
Advanced Interceptor Fighter
Supersonic Cruise Intercept Missile

Space Defense

Ground-Based Electro-Optical
Deep Space Surveillance System
Space Defense Operations Center
Pacific Barrier
Space Surveillance Radars

Deep Space Surveillance Radar
Satellite On-Board Attack
Reporting System (Warning)
Air-Launched Anti-Satellite
Surface-Based Anti-Satellite

Defensive Satellite
Space Defense Operations
Center Improvement
Ground-Based Laser
Space Based Space Surveillance

III. KEY TECHNOLOGIES

Computer-Driven Displays
IR Detector Arrays
Multi-Color IR Detector
Phased Array Radar
High Power T/R Module

Stealth Detection
Lightweight Structures
Multi-Spectral, Multi-Mode Sensors
Radiation-Hardened Microelectronics
Survivable Solar Panels
Parallel Processors
Multi-Static Surveillance
Adaptive Optics
Improved Atmospheric Transmission
Codes
Clutter Rejection/IR Background
Models

Longer Life Cryogenic Cooling
Brilliant Guidance
Noncooperative Target Recognition
Efficient Power Generation
Precision Pointing & Tracking
Hypersonic Aerodynamics
Artificial Ionospheric Mirror
Neutral Particle Beam
High Power Microwave

SPACE MISSION AREA SUMMARY

I. USER CAPABILITY NEEDS

1. Responsive Operational Launch Processing
2. Improved On-Orbit Control
3. Enhanced Space Services
4. World-Wide Navigation
5. Improved Environmental Monitoring

II. SYSTEMS & SYSTEM CONCEPTS

Current



Next Generation



Future



Launch/Orbit Transfer Vehicles

Titan II	Delta II	Advanced Launch System	Manned Single-Stage-to-Orbit Vehicle
Titan IV	Atlas/Centaur II	Orbital Maneuvering Vehicle	
Space Shuttle	IUS	Expendable Orbital Transfer Vehicle	
Centaur G	PAM-D, D-2	Reusable Orbital Transfer Vehicle	

On-Orbit Control

AFSCN	ARTS	Survivable Up/Down Links	Satellite Autonomy
DSM	FSOC	Satellite Crosslinks	Laser Satellite Crosslinks
TMGS			

Space Services

Space Test Program	Survivable Solar Panels	On-Orbit Repair/Service
	Nickel-Hydrogen Batteries	Radiation-Hardened Microelectronics

Navigation

Global Positioning System (GPS) II	GPS IIR	GPS III
------------------------------------	---------	---------

Environmental Monitoring

Defense Meteorological Satellite Program (DMSP) SD-2, SD-3	DMSP 6
--	--------

III. KEY TECHNOLOGIES

Thermal Protection Systems	Advanced Orbit Transfer Propulsion	Robotic Telepresence
Planar Solar Panels	Large Space Structure Control	High Energy Density Propellants
Improved Orbit Prediction Models	Radiation-Hardened Microelectronics	Fault-Soft, Fault-Tolerant Computer
Radiation-Hardened Electronics	Lightweight, Low-Cost Structures	Photonics
Space Transmitters and Receivers	Spacecraft Charge Control	High Power Solid State Space Communications
Improved Satellite Protection	EOIR Transmit/Receive Antennas	
	High-Efficiency Survivable Solar Cells	
	Autonomous Guidance	
	Wideband Survivable Comm Links	
	Improved Environmental Models	

MOBILITY/SOF MISSION AREA SUMMARY

I. USER CAPABILITY NEEDS

1. Intertheater Airlift - build to 66 MTM/D
2. Intratheater Airlift - outside cargo and tonnage
3. Combat Rescues - quantity and quality of assets
4. Meteorological Capabilities - global weather coverage, modeling, observe/forecast near-earth space conditions
5. Special Operations - long-range infiltration, gunship assets

II. SYSTEMS & SYSTEM CONCEPTS

Current



Next Generation



Future



Intertheater Airlift

C-141 B
C-5 A/B
KC-10
Civil Reserve Air Fleet

C-17

Advanced Strategic Airlifter

Intratheater Airlift

C-130

C-17

Advanced Tactical Transport

Special Operations

MB-60
C-141 Special Ops Low Level (SOLL)
C-130 SOLL
MC-130 E/H
AC-130 A/H/U
MH-53 J
HC-130

CV-22

Special Ops Transport Follow-on
Special Ops Gunship Follow-on

Meteorological Capabilities

WC-130
DMSP
Battle Field Weather and
Observation Forecast System

Automated Weather Distribution System
Next Generation Radar
DMSP (Block change)

4-D Models
Weather Data Sensors on
Non-Weather Platforms
DMSP (Advanced)

III. KEY TECHNOLOGIES

Rough Field Landing Gear
Supercritical Airfoil
Gunship Fire Control System
Rapid Cargo Loading

Artificial Intelligence
Lightweight Materials
Multi-Spectral, Multi-Mode Sensors
Parallel Processors
IR Signature Reduction
Ballistic Survivability
Situational Awareness Aiding

Passive Low-Level Navigation
Autonomous Landing
Passive Self-Protection
Stealth
Rapid Meteorological Forecasting
High Performance Turbine Engine
STOL/STOVL/VTOL
Ultra-Lightweight Materials

TACTICAL MISSION AREA SUMMARY

I. USER CAPABILITY NEEDS

- | | |
|---------------------------------|--|
| 1. Night and Weather Capability | 6. Aero System Survivability |
| 2. Air-to-Air Kill | 7. Ability to Find and Kill Mobile Targets |
| 3. Airfield Attack | 8. Hard Target Kill |
| 4. Aero System Supportability | 9. Long-Range Interdiction |
| 5. Reduced Aircrew Workload | |

II. SYSTEMS & SYSTEM CONCEPTS

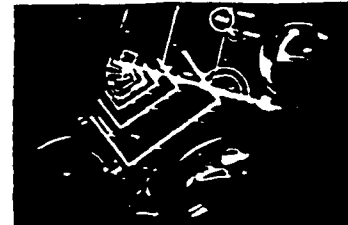
Current



Next Generation



Future



Aircraft

F-16A/C
F-16A/C/E
F-111
A-10A
A-7D/F
F-4D/E/G

Agile Falcon
Follow-on Wild Weasel
Multi-Mission Remotely Piloted Vehicle
All Weather F-16
Advanced Tactical Fighter
Follow-on Attack Aircraft
Close Air Support Replacement

Follow-on Interdiction Aircraft
Robotic Air Vehicle
Complementary Multi-Role fighter
High Altitude/Mach Aircrew
Protective Equipment

Avionics

Tactical Identification
MILSTD-1760 Data Bus for Munitions
LANTRN

Non-Cooperative Identification
Strike Data Link
Intra-Flight Avionics Suite
Integrated Sensor Suite

Super Cockpit
Automated Attack System

III. KEY TECHNOLOGIES

Battle Damage Repair
Improved Reliability & Maintainability
Secure Communications
Tactical Decision Aids
Integrated Electronic/Information Processing

Radiation-Hardened Sensors
Head-Stearable Targeting
Multi-Spectral, Multi-Mode Sensors
Self-Repairing Flight Controls
Lightweight Structures
Flight Internetworking
Night Vision Capability
Improved Displays
Stealth

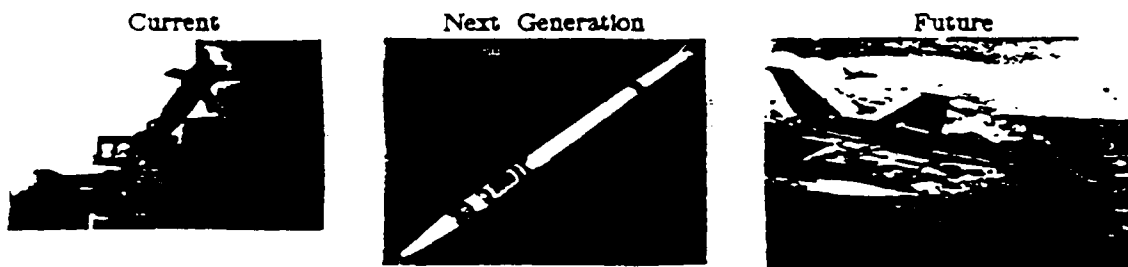
High Performance Turbine Engines
Acoustic Signature Reduction
STOL/STOVL/VTOL
All-Aspect Heads-up Display
Inflight Thrust Reversing
Few vs. Many Engagement Avionics
Discriminating Attack Capability
Robotic Servicing
Artificial Intelligence/Flight Decision Aids

ARMAMENT MISSION AREA SUMMARY

I. USER CAPABILITY NEEDS

- | | |
|------------------------------------|--|
| 1. Night and In-Weather Employment | 8. Low Drag/Low Observability |
| 2. Autonomous Launch and Leave | 9. Improved Sortie Generation |
| 3. Increased Stand-Off Range | 10. Reduced Aircrew Workload |
| 4. Near Zero CEP Guidance | 11. Improved SEEK EAGLE Certification Capability |
| 5. Multiple Kills per Pass | 12. Improved Air-to-Air Missile Kill Probability |
| 6. Hard Target Kill | 13. Improved Air-to-Air Lethality Envelope |
| 7. Countermeasure Resistance | |

II. SYSTEMS & SYSTEM CONCEPTS



Air-to-Air

ADM-7 Sparrow
ADM-9 Sidewinder
ADM-120 AMRAAM

ADM-132 ASRAAM
AMRAAM PDI

Advanced Air Superiority Missile

Air-to-Ground

MK-20 Rockeye
MK-82/84
BLU 107 Duraandal
BLU 108 I-2000
CBU-87 CEM
CBU-88 Gator
CBU-97 SPW
20 mm Gun
30 mm Gun

AGM-66 Maverick
AGM-84 Harpoon
AGM-88 HARM
AGM-130
AGM-138 Tact
Rainbow
GBU-10/12 LGB
GBU-24 LLLGB
HAVE NAP

Millimeter Wave Maverick
Conventional Cruise Missile
Hypervelocity Missile
Modular Standoff Weapons
Inertially Aided Munition
Hard Target Weapon
Autonomous Guided Weapon

Autonomous Anti-Armor Weapon System
Autonomous High Value Target Weapons
Hypervelocity Submunition
Advanced Air Scatterable Mines

III. KEY TECHNOLOGIES

Data Link
Laser Guidance
Electronic Fuse
Imaging Infrared Seeker
Subsonic Dispenser

Autonomous Guidance
Hard Target Warhead
High Performance, Low Observable Motors
Lightweight/Low Observable/
Optimal-Shaped Structures
Insensitive Munitions
Multi-Spectral, Multi-Mode Seekers
Multi-Role/Multi-Mode Warheads
Target Recognition Algorithm
Low Cost Components
Smart Fuzing
Computational Fluid Dynamics

Hard Target Penetrator
Brilliant Guidance
Hypersonic Separation/Aerodynamics
High Energy Insensitive High Explosives
High Temperature Materials
Hypersonic Guidance Integration
Artificial Intelligence

RECCE/INTEL MISSION AREA SUMMARY

I. USER CAPABILITY NEEDS

1. Expanded Spectrum, Passive Coverage
2. Knowledge-Based Correlation/Fusion/Auto-Target Recognition
3. Unit-Level Intelligence Stations
4. Robust, Secure Low-Probability-of-Intercept Communication Net

II. SYSTEMS & SYSTEM CONCEPTS

Current



Next Generation



Future



Collection Platforms

Satellites
U-2
SR-71
RF-4C
Unmanned Vehicles

TR-1
RC-135
C-18
C-130

FX-R Follow-on Tactical Recon

Hypervelocity Vehicle
Tactical Low-Cost Drones
High-Altitude, Long-Endurance
Vehicle

Sensors

Film Cameras
Electro-Optical Sensors (ATARS)
Synthetic Aperture Radars (ASARS I/II)
ISTARS
Infrared Sensors
SIGINT Sensors (RDMSS)

Long-Range Optical Sensor
Advanced ELINT Upgrade
Time-Correlated SIGINT
Multi-Spectral Sensors
Advanced Emitter Location
Advanced FLIR/Radar/LADAR

Advanced Frequency Domains
Expendable Sensors
Follow-On RIVET JOINT

Processing/Exploitation/Production

Film Processing/Exploitation Facilities
Digital Exploitation Systems (TRUGS, ISIPS)
SIGINT Processors
Digital Data Fusion System (JTFF)

3-D Image Manipulator
Wide-Band Recording & Mass
Storage Devices
Cartographic Correlator
Automatic Target Recognizer
Real-Time SIGINT Processor

Expert Analyst/Image Interpreter
Language Translation/Transcription
Devices
Holographic Exploitation System

Dissemination

Frequency Hopping (HAVE QUICK)
Unit-Level Networks (SENT BYTE)
Digital Communication Lines (DDN/DSN)
Digital Imagery Transmission (DITS)
Anti-Jam Worldwide Comm (MILSTAR, JTIDS)

JTIDS MIDS
Integrated Voice/Data Switch
Multi-Level Security
Anti-Jam HF Communications Radio

Wide-Band HF Radio
Multi-Media Radio
Radar-Integrated Data Link
Laser Communication System

III. KEY TECHNOLOGIES

Digital Data Links
Electro-Optic Sensors
Digital Recorders
Multi-Sensor Fusion
Clutter Rejection
Rapid Software Prototyping

Parallel Processing
Pattern Recognition
Photonic Materials/Devices
Stealth
Laser Communication Devices
Multi-Level Secure
Distributed/Parallel Processors

Real-Time Target Recognition
High-Altitude Engines/Aerodynamics
Hypersonic Engines/Aerodynamics
Machine Intelligence
Smart Skins/Conformal Sensors
Low-Probability-of-Intercept Sensors
and Communications

ELECTRONIC COMBAT MISSION AREA SUMMARY

I. USER CAPABILITY NEEDS

1. Self-Protection for All Combat Aircraft (includes airlift)
2. Destructive Suppression of Threats
3. Disruptive Suppression of Threats
4. Simulation, Testing, and Training

II. SYSTEMS & SYSTEM CONCEPTS

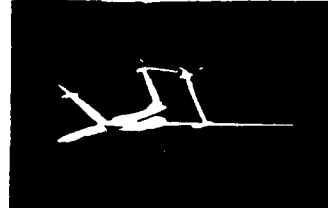
Current



Next Generation



Future



Self Protection

Radar Warning Receivers
Expendables (chaff & flares)
Limited Missile Warning
Radio Frequency (RF) Jammer
RF Techniques

Warning/Situation
- MMW/IRST/Laser
- Range & Bearing
Missile Warning/Expendables
- Automatic dispense
- Towed Decoys
Internal Jammers
- All threats/signals
- Stealth integrated

Totally Integrated Situation Display
- Launch footprint
- Soviet C3
Multi-Spectral Expendables
Directional Dispense
Laser/HPM Protection
Full-Spectrum Jammers
Self-Protect Weapon
- RF/IR/Laser/HPM

Destructive Suppression

F-4G's/APR-38
HARM/Shrike/LAPs
Tact Rainbow

Wild Weasel Follow-on/Wingman
Dual-Mode ARM Seeker
Destructive Drones vs
- Threat/EW/GCI/ACQ
- Comm Jammers
SEEK SPINNER

Upgraded Processor
Low Cost RF Seeker
Destructive Drones vs
- HPM/MMW/EO/Laser

Disruptive Suppression

EF-111A
Force Structure #2
EC-130H Compass Call
AFCEC Limited C3CM
Data Base

Expanded Frequency Coverage
Improved ERP
EC-130H Self-Defense
AFCEC Data Base
Jamming Drones

Low-Band Advanced Jammer
Drones vs All Signals
Follow-on C3CM Systems
High Power Countermeasures
Comm Deceptions

Testing and Training

REDCAP/AFEWES/PRIMES
Early Threat Simulators
Training Ranges
IFAST Airborne Test

RMAA/ECDES/RECS/GWEP
Advanced Threat Simulators
- RF/IR/EO/Laser
- Advanced C3 Net
TFAAS Advanced Test
EC Vulnerability Analysis

Embedded Training
Predictive Modeling
Advanced Facilities
Total Platform Test
Realistic IADS Range
Total EM Environment Modeled

III. KEY TECHNOLOGIES

Monopulse ECM
Reprogrammable ECM Pods
Flare/Chaff Dispensers

MMW/EO/Laser Detectors
Parallel Processors
Conformal Antennas
Full-Soft, Fault-Tolerant Electronics
Integrated EW Systems

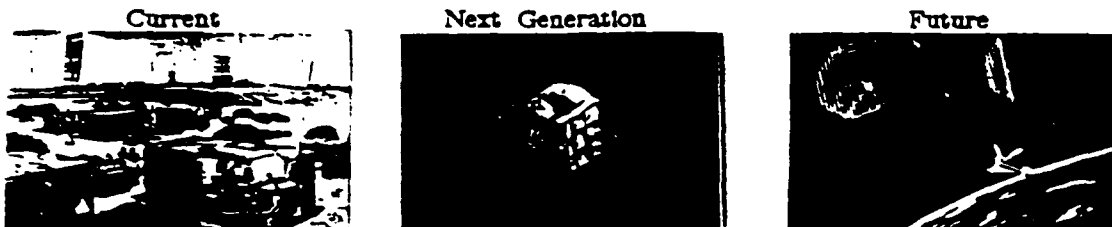
Low Signature Threat Detectors
High Power Microwaves
Artificial Intelligence for Threat
Monitoring

COMMAND AND CONTROL MISSION AREA SUMMARY

I. USER CAPABILITY NEEDS

1. Improve Battle Management Capability - Information Processing and Decision Aids
2. Reduce Communication Vulnerability - ECM, EMP, Physical Attack
3. Provide Integrated Tactical Warning and Assessment - Air, Space, Missile, and Intelligence
4. Improve Theater Surveillance - Detection, Tracking, and Identification

II. SYSTEMS & SYSTEM CONCEPTS



Current		Next Generation	Future
<i>Strategic</i>			
POC/ET	GWEN	WWARNCP-R	Ballistic Missile Defense (BMD)
MRT	SACDIN	Offutt Processing & Correlation Center	Command Center
RAMSTAT	AACE	Strategic War Planning System	BMD Battle Management C3
NPES	AEPDS	SAC Adaptive Planning System	AWPDS Airborne
IPS	IRSC	Attack Warning, Processing, & Display (AWPDS) Mobile	
SCS	CCPDS-R	Advanced High Frequency	
CSSR	Granite Sentry	Tactical Data Station	
GDSS	HF Upgrade	Small ICBM C3	
USTS	Peacekeeper C2		
<i>General Purpose Forces</i>			
MCE/GACC	TRI-TAC	Advanced Planning System	Multimedia Radio
AWACS IRP	JSTARS	JTIDS MIDS	Advanced Airborne
ABCCC	JTIDS	Combat Identification Sensor	Surveillance Radar
EFEL	HAVE SYNC	Media Resource Controller	Mobile Air Base Command and Control
ULSA	CTAPS	Network Management Processor	Advanced Tactical
TACC	ASOC	Mission Support System	Surveillance Radar
HAVE QUICK IIA			
MARK XV			
CONSTANT WATCH			
<i>Common</i>			
MILSTAR	DSCS III	DSCS III C	Multi-Satellite Network
AFSATCOM	NAES/GMF	Multilevel Security	Advanced Satellite Communications
FLT SAT F/O WIS		Multinet Gateway	Terminal
Digital European Backbone		Integrated Voice/Data Switch	Wideband HF Radio
Microwave Landing System		Anti-Jam HF Communications	ATALARS
Mobile Radar Approach Control			

III. KEY TECHNOLOGIES




Rapid Software Prototyping	Multi-Level Secure Distributed/Parallel Processors	Artificial Intelligence
Clutter Rejection	Smart Workstations for Battle Management	High Bit Rate Burst Radio
Anti-Jam, Low Probability of Intercept Techniques	Laser Communication Devices	Integrated Photonics
	AI Processing & Correlation Techniques	Smart Skin/Conformal Antennas
	Multi-Spectral NCTR Sensors	Real-Time, 3-D Situation Displays
	Photonic Materials/Devices	Low Observable Detection & Tracking
	Wideband EHF Processors	

AIR BASE OPERABILITY MISSION AREA SUMMARY

I. USER CAPABILITY NEEDS

- | | |
|-------------------------------------|--|
| 1. Air Base Defense | 4. Post-Attack Sortie Generation |
| 2. Ability to Survive during Attack | 5. Air Base Wartime Functional Support |
| 3. Post-Attack Recovery | |

II. SYSTEMS & SYSTEM CONCEPTS

Current	Next Generation	Future
		
<i>Defend</i>		
Sandbagged Foxholes	Defensive Fighting Positions	Intrusion Barriers
<i>Survive</i>		
Decoys Survivable Collective Protection Shelter (SCPS) Individual Protective Equipment	Infrared Reflectors HYPARS Shelters, Polymer Concrete Personal Cooling Systems	Stealth for Facilities Relocatable High Value Targets Impermeable Suits
<i>Recover</i>		
Aluminum Aircraft Repair Patch Fiberglass Crater Covers 1 Man - 1 Bomb Dismanting Air Transportable Hospital	Transparent Cockpit Patches Polymers for Rapid Runway Repair ORACLE & FLAIL, MARV/SMUD SCPS - Medical	Self-Repairing Avionics Reduced Air Base Dependence Robotic & Remote Electronic Dismanting Treatment for Biological Weapons
<i>Generate</i>		
Open Ramp Fueling Remote Munitions Storage	Revetted/Shelter-adjacent Fueling Close Munitions Storage	Integral Shelter Fueling Insensitive High Explosives
<i>Support</i>		
Single-node Utilities Unhardened Vehicles Unhardened Fire Fighting Equipment Unhardened Communications	Redundant Utilities Off-Road Vehicles Hardened Fire Truck BRAAT Communication System	Hardened Utilities & Distribution Hardened Vehicles Robotic Fire Fighting Fiber-Optic, Armored Communication Cables

III. KEY TECHNOLOGIES

Hardened Collective Protection Shelters Chemical Protection (Suit & Mask)	Survivable Base Communications Polymer Concrete Plastic Explosive Detectors Chemical/Biological Detectors and Containment	Rapid Repair of Advanced Materials STOL/STOVL/VTOL Robotic Operation in Hostile Environment
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TECHNOLOGY AREA SUMMARIES

Capability needs in the 10 Air Force mission areas can be met from a menu of system concepts enabled by proven demonstration of the key technologies required for those concepts. Additionally, the Air Force recognizes a broad S&T Program is essential to support anticipated user needs and to preclude technological breakthrough by our adversaries. To meet this challenge, the Air Force designated S&T as an executive program to give it visibility and stature commensurate with major system acquisition programs. A Program Executive Officer (PEO) at Headquarters Air Force Systems Command will direct program planning and execution by field program directors in the 13 major AF technology areas depicted in this section. The Air Force has instructed the PEO to establish S&T as a "corporate" investment budgeted at a certain percent of Air Force Total Obligation Authority that is to be determined annually by the corporate Air Force. Summaries of the 13 technology area plans appear on pages 21 - 24.

How to read the summaries:

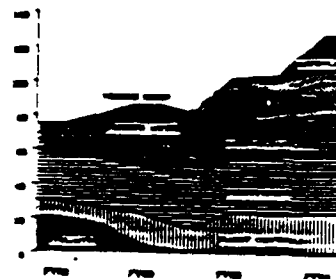
This section identifies the major technology thrusts within each of the 13 Air Force technology areas and depicts planned funding levels for those thrusts through 1994. The Research Sciences technology area (page 24) encompasses the entire Air Force basic research (6.1) program and receives expanded coverage to provide more meaningful descriptions of their major technology thrusts.

MAJOR TECHNOLOGY THRUSTS



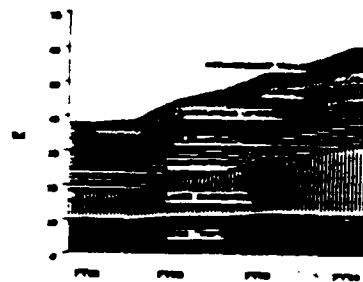
AIR VEHICLES

Advanced STOVL
Vehicle Equipment (Landing Gear, Crew Escape)
Fighter Battle Management/Super Cockpit
Aeromechanics/Hypersonics
Structures
Flight Controls
STOL/Maneuver Technology Demonstrator



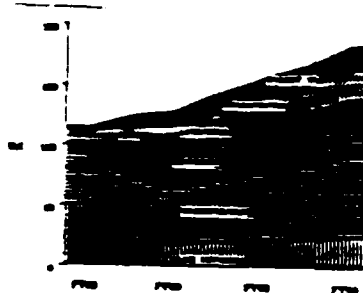
MATERIALS

Non-Destructive Evaluation
Fluids/Thermal Protection Materials
Nonlinear Optical Materials
Ultrastructures/Electromagnetic Materials
Composites/Lightweight Materials
Laser Hardened Materials
High Temperature Materials



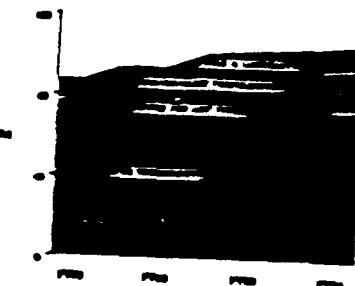
AVIONICS

Target Recognition/Identification & Fire Control
Communications/Navigation Systems
Avionics System Integration (Signal/Data Processing, AI, Pilot Vehicle Interface)
RF/EO Sensor Technology
RF/EO/IR Warning and Countermeasures
Electronic Components and Devices (Microwave, EO, Microelectronics)



AEROPROPULSION

Fuels & Lubricants
Ramjet/Scramjet Propulsion
Power for Advanced Military Systems
High Performance Turbine Engine Technology

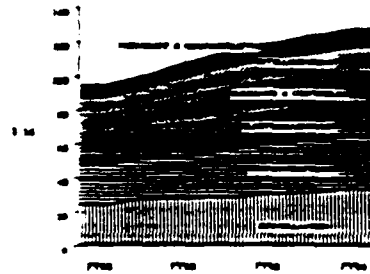


MAJOR TECHNOLOGY THRUSTS



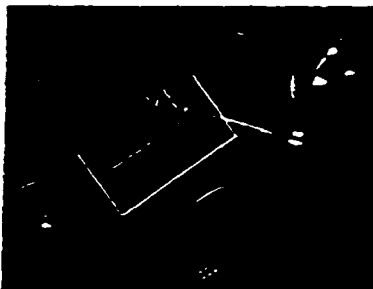
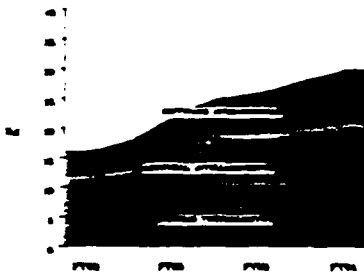
CM

Reliability and Compatibility
Intelligence
Command and Control
Electromagnetic/Solid State Sciences
Communications
Surveillance



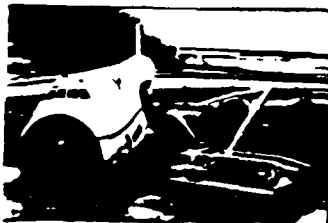
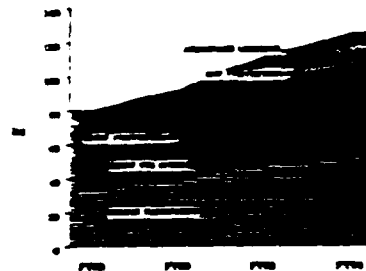
COMPUTATIONAL SCIENCE

Software Engineering
Artificial Intelligence
Systems Technology



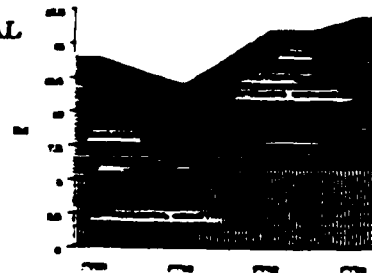
HUMAN SYSTEMS TECHNOLOGY

Aerospace Medicine
Environmental Protection
Crew Protection
Crew Systems Integration
Human Resources



CIVIL & ENVIRONMENTAL ENGINEERING

Noise Technology
Air Base Utilities
Aircraft Operating Surfaces
Air Base Facilities
Fire Technology
Environmental Quality

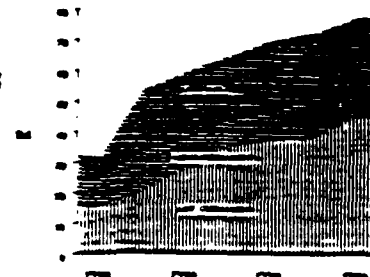


MAJOR TECHNOLOGY THRUSTS



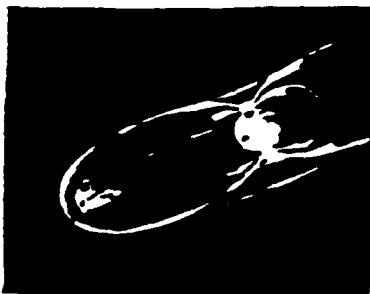
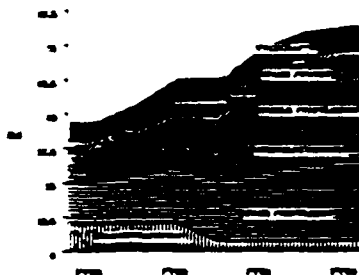
CONVENTIONAL ARMAMENTS

Ordnance
Aeromechanics
Advanced Guidance



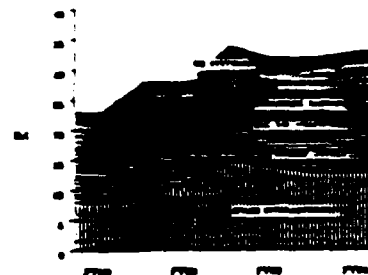
SPACE & MISSILES

Spacecraft Technologies
Space Power
Missile Propulsion
Radiation Hardened Microelectronics
Space Propulsion
Survivable Space Communications



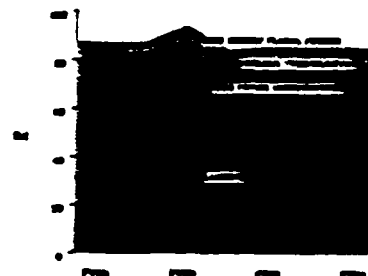
GEOPHYSICS

Environmental Effects on CM Systems
Full Spectrum Environmental Sensors
Strategic Warning and Targeting
Tactical Electro-Optical Weapons
- Environmental Effects
Target Detection and Background
Space System Environmental Interactions



ADVANCED WEAPONS

High Energy Plasma Physics
Nuclear Technology
High Power Microwaves
Lasers



MAJOR TECHNOLOGY THRUSTS

RESEARCH SCIENCES

LIFE SCIENCES

- Cognition and Human Performance
- Visual Information Processing
- Auditory Information Processing
- Neuroscience

PHYSICAL & GEOPHYSICAL SCIENCES

- Linear and Nonlinear Optics
- Directed Energy
- Terrestrial Physics
- Space Physics

MATHEMATICAL & INFORMATION SCIENCES

- Computer Science
- Computational Mathematics and Optimization
- Probability and Statistics
- Applied Mathematics and Control Theory

AEROSPACE SCIENCES

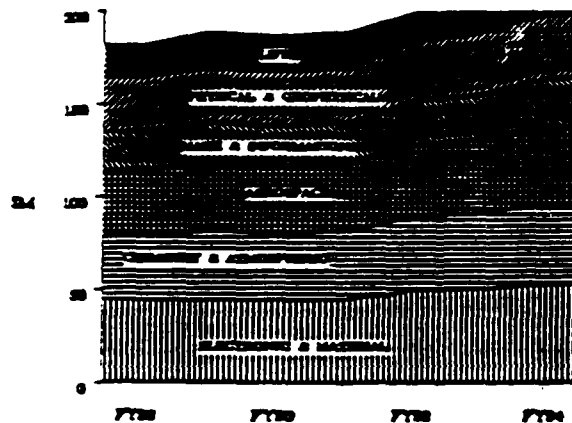
- Aerodynamics of External & Internal Flows
- Turbulence, Unsteady Flows & Control
- Structures: Durability, Dynamics, Controls, & Interactions
- Rocket Propulsion: Chemical, Electric, & Space
- Airbreathing Propulsion: Reacting Flows, Diagnostics, and Hypersonic Combustion

CHEMISTRY & ATMOSPHERIC SCIENCES

- Aerospace Materials Processing & Characteristics
- Molecular Kinetics
- Surface Dependent Properties
- Optical & Infrared Atmospheric Properties
- Ionosphere/Thermosphere Dynamics
- Meteorology of the Low- and Mid-Atmosphere

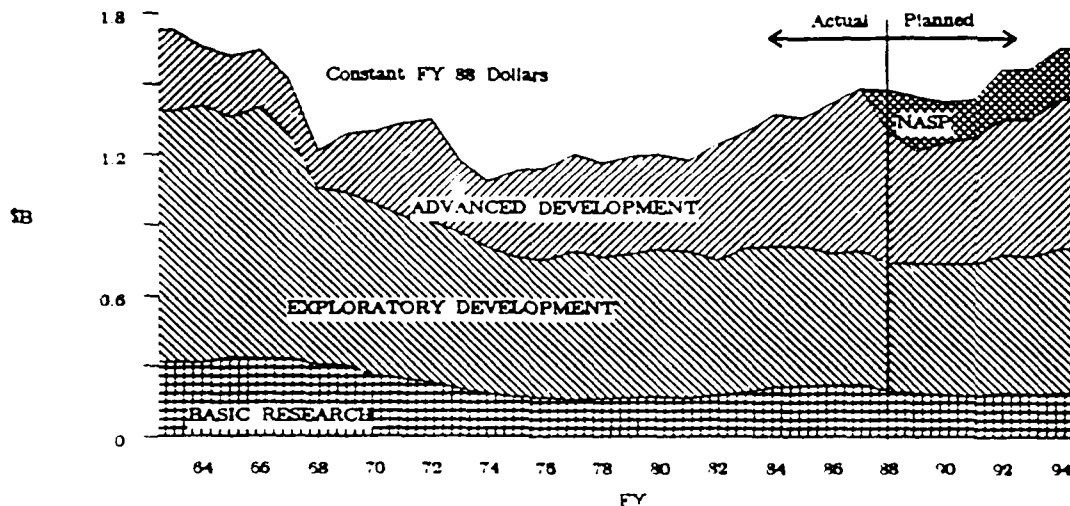
ELECTRONIC & MATERIAL SCIENCES

- Electronics
- Photonics
- Superconductivity
- Antennas and Propagation
- Structural/High Temperature Materials

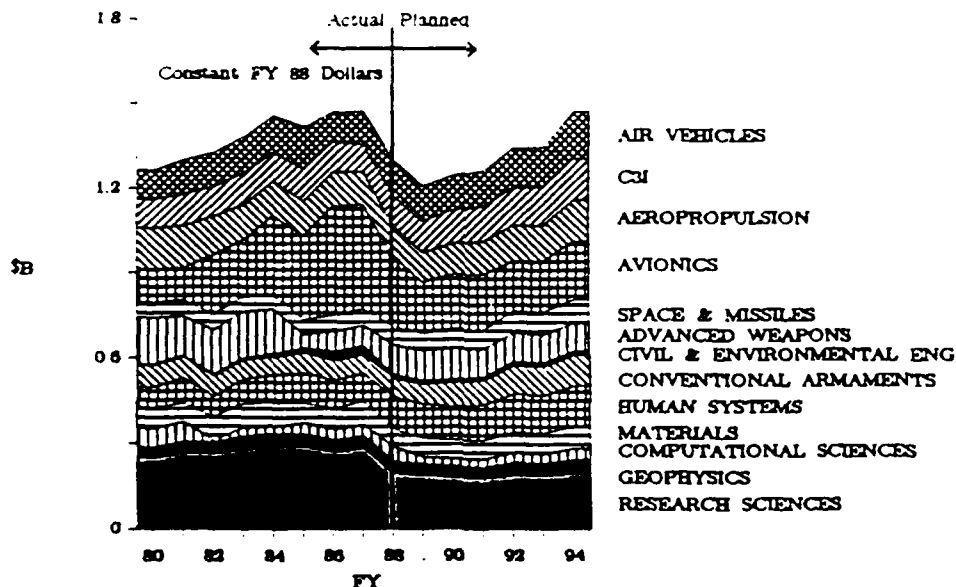


AIR FORCE S&T INVESTMENT SUMMARY

The charts below present a summary of the total Air Force S&T budget from two different perspectives. An historical look at the S&T Program by budget category shows that S&T enjoyed its highest funding level in the early 60s, reached a low in the early 70s and is now climbing toward levels necessary to ensure US qualitative superiority.



The chart below shows where the Air Force places its S&T funding emphasis and highlights variations in individual funding profiles. For example, in the 1980s, a heavy commitment was made to VHSIC in the Avionics area. Changes to the primary areas of interest reflect response to new user requirements, as well as influences by promising technological breakthroughs.



SCIENCE AND TECHNOLOGY
AND
DEVELOPMENT PLANNING
PROGRAM OBJECTIVES

The previous charts reflect actual and planned Air Force Science and Technology funding. The following defines the future Air Force Science & Technology and Development Planning investment strategy which will be used in structuring future Air Force Research and Development programs.

I. SCIENCE AND TECHNOLOGY PROGRAM OBJECTIVES

A. General

1. Increase emphasis in pursuing technologies used to modify operational systems and improve systems in development or production, especially ones that can provide: increased performance; enhanced reliability, availability, and maintainability; and reduced cost of ownership.
2. Ensure advanced development programs are properly phased to support realistic windows of opportunity for technology transition.
3. To respond to increased demands on S&T budgets, capitalize on the S&T efforts of other Services, agencies, allies, industry, and academia.
4. Ensure S&T supports the growing national concern over regional conflicts. In particular, coordination of C3I, avionics, and conventional weapons technology programs must be accomplished with other Services to preclude duplication, improve interoperability, and minimize development risks.
5. The Basic Research program should be stabilized at no less than 15 percent of the resources available for S&T.

B. Specific

1. Areas for increased emphasis:

- a. Enhance research efforts in the enabling technologies of materials, electronics, photonics, computational sciences, expert computer systems, and superconductivity.
- b. Exploit US technological advantages in sensor fusion and processing to achieve advanced capabilities in wide area surveillance, targeting, cockpit situational awareness (Super Cockpit), and autonomous guided armaments—particularly multi-mode/multi-spectral sensors, multi-static receivers and expert system-aided decision making.
- c. Transition mature directed energy technologies.
- d. Enhance spacecraft technology integration to achieve survivable, longer life, and multi-mission/adaptive space systems.
- e. Ensure reliability, maintainability, supportability, and producibility considerations are included in advanced technology developments with the goal of increased sortie generation and reduced cost of operation. Increase activities in smart built-in-test (SMART BIT) and Unified Life Cycle Engineering (ULCE).
- f. Pursue ICBM technologies that provide for future options to improve booster capabilities (including low cost, reliable guidance), survivability, defense penetration, capabilities against SRTs and deeply buried targets, as well as readiness of existing ICBMs.
- g. Expand basic research in High Energy Density Propellants and other advanced propulsion concepts.

2. Areas for continued emphasis:

- a. Sustain aggressive High Performance Turbine Engine (HPTE) research to capitalize on opportunities for technology transition.
- b. Continue investments in technologies supporting civil and environmental engineering to enhance air base operations.
- c. Develop STOL/STOVL/VTOL technologies and structure performance demonstrations to provide options for future development of advanced fighter and transport systems.
- d. Focus current investments in robotics to explore the feasibility of using telepresence for remote operations in space and other hazardous/harsh environments.

3. Additional

- a. All Air Force investments in advanced development hypersonic structures and propulsion technologies will be the responsibility of the National Aerospace Plane (NASP) program, while Air Force S&T will maintain a broad-based program of hypersonic research (6.1 & 6.2) separate from but coordinated with the NASP program.
- b. Reduce investment in advanced development efforts that have no clear transition to a system application.

II. DEVELOPMENT PLANNING PROGRAM OBJECTIVES

Development planning focuses the Air Force S&T investment to both meet users needs and provide opportunities for new warfighting capabilities. Accordingly, AFSC performs broad mission area analyses in concert with the operational commands and Headquarters USAF, to assist in defining user requirements. These requirements may be to apply technologies to correct deficiencies or, in some cases, to achieve new military capabilities. With this "menu" from the users, AFSC will formulate and evaluate alternative system concepts to meet the user needs. The best of these concepts may proceed forward into demonstration/validation programs. Prioritized FY 89 development planning objectives follow below:

A. Mission Area Analysis

1. Provide long-term analytical efforts designed to identify capabilities needed to exploit enemy vulnerabilities.
2. Explore the potential uses of hypersonic technology for strategic and tactical missions, reconnaissance and intelligence, and air defense roles.
3. Explore the ramifications of potential Soviet militarization of space.

4. Continue efforts to determine space architecture and force structure requirements with emphasis on assured access and space control. Explore the optimal role for man in future operational systems.

5. Explore joint force requirements with particular emphasis on C3I.

6. Evaluate the military potential of directed energy weapons.

7. Continue to explore uses of unmanned vehicles to complement a variety of missions.

B. Concept Formulation

1. Formulate and evaluate concepts for countering strategic relocatable targets and attacking deeply buried targets.

2. Investigate the strategic capabilities of advanced conventional armaments.

3. Develop concepts which leverage technology in low intensity conflict.

4. Formulate concepts for self-protection, destructive and disruptive suppression, and training improvements in electronic combat.

5. Develop concepts for advanced surveillance systems. Candidates include SEWS follow-on, Space-Based Radar, and Advanced Surveillance and Tracking Technologies.

6. Investigate concepts for expanding human performance capability.

7. Explore alternate approaches for evaluating the effectiveness of pilot training.

8. Develop concepts for stealth detection.

9. Formulate and evaluate concepts which could apply STOL, STOVL, and VTOL in tactical fighters, SOF, and transport aircraft missions.

10. Pursue new concepts with multi-static, multi-spectral surveillance capabilities for attack warning/assessment.

11. Evaluate survivable multi-media secure communication links in support of improved C2, Integrated Tactical Warning & Assessment surveillance systems, and multi-static surveillance capabilities.

12. Consider capabilities of GPS, as appropriate, when developing the full range of concepts directed herein.

13. Create concepts to improve noncooperative target ID.

GLOSSARY

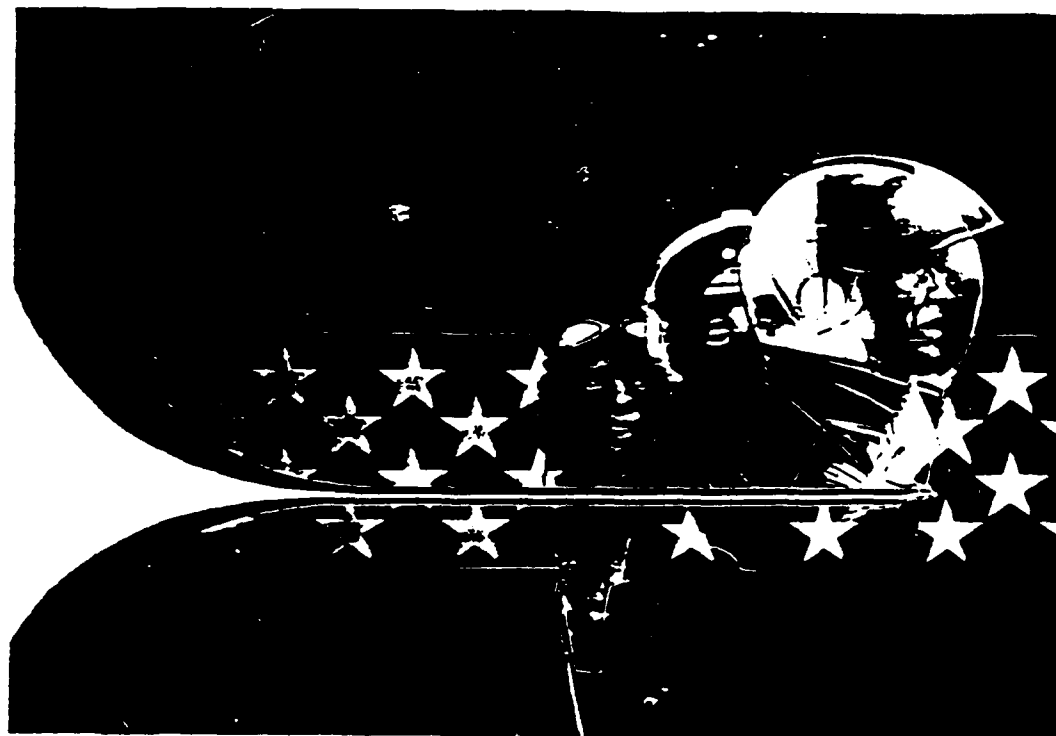
AACE	Aircraft Alerting Comm Electromagnetic Pulse
ABCCC	Airborne Battlefield Command and Control Center
ACQ	Acquisition Radar Threat
AEPDS	Automated EAM Processing & Dissemination System
AEDT	AEELS Fixed Downlink Terminal
AFEWC	Air Force Electronic Warfare Center
AFEWES	Air Force Electronic Warfare Evaluation Simulator
AFSATCOM	AF Satellite Communications
AFSC	Air Force Systems Command
AFSCN	AF Satellite Control Network
AI	Artificial Intelligence
AMRAAM	Advanced Medium Range Air to Air Missile
ARM	Anti-Radiation Missile
ARTS	Advanced Remote Tracking Station
ASARS	Advanced Synthetic Aperture Radar System
ASOC	Air Support Ops Center
ASRAAM	Advanced Short Range Air to Air Missile
ATALARS	Advanced Tactical Aircraft Launch and Recovery System
ATARS	Advanced Tactical Air Reconnaissance System
AWACS	Airborne Warning and Control System
BMEWS	Ballistic Missile Early Warning Systems
BRAAT	Base Recovery After Attack
C2	Command and Control
C3	Command, Control, and Communications
CCCM	C3 Countermeasures
C4	Command, Control, Communications, and Intelligence
CCPDS-R	Command Center Processing and Display System Replacement
CEM	Combined Effects Munition
CEP	Circle Error Probable
CSSR	Communications System Segment Replacement
CTAPS	Contingency TAC Automated Planning System
DDN	Defense Data Network
DEW	Distant Early Warning
DSCS	Defense Satellite Communications System
DSM	Data Systems Modernization
DSN	Defense Switched Network
DSP	Defense Support Program
EC	Electronic Combat
ECDES	EC Digital Evaluation System
ECM	Electronic Countermeasures
EHF	Extremely High Frequency
EIFEL	Electronic Information C2 System for the Luftwaffe
ELINT	Electrical Intelligence
EM	Electromagnetic
EMP	Electromagnetic Pulse
EO	Electro-Optical
ERP	Effective Radiated Power
EW	Electronic Warfare
FLIR	Forward Looking Infrared
FLT SAT F/O	Fleet Satellite Follow-On
FSOC	Fairchild Satellite Operations Complex

GLOSSARY

GACC	Ground Attack Control Center
GCI	Ground Controlled Intercept Threat
GDSS	Global Decision Support System
GWEF	Guided Weapons Evaluation Facility
GWEN	Ground Wave Emergency Network
HARM	High Speed Anti-Radiation Missile
HF	High Frequency
HPM	High Power Microwave
HUD	Heads-up Display
HYPARS	Hyperbolic Paraboloid Surface
IADS	Integrated Air Defense System
ICBM	Intercontinental Ballistic Missile
IFAST	Integration Facility for Avionics Systems Test
ITS	Intratheater Imagery Transmission System
INS	Inertial Navigation System
INTEL	Intelligence
IOC	Initial Operational Capability
IPS	Information Processing System
IR	Infrared
IRP	Improved Radar Program
IRST	IR Search and Track System
IUS	Inertial Upper Stage
JRSC	Jam Resistant Secure Communications
JSIPS	Joint Service Imagery Processing System
JSTARS	Joint Surveillance and Target Attack Radar System
JTFP	Joint Tactical Fusion Program
JTIDS	Joint Tactical Information Distribution System
LADAR	Laser Detection and Ranging
LANTIRN	Low Altitude Night Targeting IR Navigation
LAPs	Launcher Avionics Packages
LGB	Laser Guided Bomb
LLGB	Low Level Laser Guided Bomb
MARV	Mobile Armored Reconnaissance/Operational Vehicle
MCE	Modular Control Element
MIDS	Multifunction Information Distribution System
MILSTAR	Military Strategic Tactical and Relay
MMW	Millimeter Wave
MOU	Memorandum of Understanding
MRT	Miniature Receive Terminal
MTM/D	Million Ton Miles/Day
NABS/GMF	NATO Airbase Satellite/Ground Mobile Force
NCTR	Non-Cooperative Target Recognition
NPES	Nuclear Planning and Execution System
ORACLE	Ordnance Rapid Area Clearance System
OTH-B	Over-the-Horizon Backscatter

GLOSSARY

P3I	Pre-Planned Product Improvement
PAM	Payload Assist Module
PF II	Project Forecast II
POC/ET	Proof of Concept/Experimental Testbed
POM	Program Objective Memorandum
PRIMES	Preflight Integration of Munitions and Electronic Systems
RAMSTAT	Recovery Airfield Monitoring and Status System
RDMSS	Rapidly Deployable Mobile SIGINT System
RD&E	Research, Development, Test, and Evaluation
RECCE	Reconnaissance
RECS	Reconfigurable EC System
REDCAP	Real-time Electromagnetic Digitally Controlled Analyzer and Processor
RMAA	Red Mission Area Analysis
SACDIN	SAC Digital Network
SCIS	Survivable Communications Integration System
SPW	Sensor Fuzed Weapon
SIGINT	Signals Intelligence
SMUD	Standoff Munitions Disrupter System
SOF	Special Operations Forces
SRAM	Short Range Attack Missile
SRTs	Strategic Relocatable Targets
STOL	Short Takeoff and Landing
STOVL	Short Takeoff and Vertical Landing
T/R	Transmit and Receive
TACC	Tactical Air Control Center
TFAAS	Test Facility for Advanced Avionics Systems
TMGS	Transportable Mobile Ground Station
TRI-TAC	Tri-Service Tactical Communications
TRGS	TR-1 Ground Station
ULSA	Ultra-Low Side-lobe Antenna
USD&E	Under Secretary of Defense Research and Engineering
USTS	UHF Satellite Terminal System
VHSIC	Very High Speed Integrated Circuits
VTOL	Vertical Takeoff and Landing
WIS	Worldwide Military Command Control System (WWMCCS) Information System
WWABNCP-R	Worldwide Airborne Command Post Replacement



WE MEET THE USER'S NEEDS

Section II

WORKING GROUP B, PROGRAM COORDINATION

WORKING GROUP B, PROGRAM COORDINATION

A. INTRODUCTION

1. Background

The Task Force for Improved Coordination of DoD Science and Technology Programs was formed in order to develop a strategy and implementation plan for improving the overall coordination of Science and Technology (S&T) Programs within the Department of Defense. There is currently no forum that provides a coordinated, overall picture of DoD technology efforts that supports a long-term coordinated military plan for the future protection of our country.

There is a need for a strong, focused, and coordinated S&T program to support our policy of reliance on superior technological capability in all aspects of our military forces. In an era when budgets are declining and our major adversary is closing the technology gap, it is of vital importance that our S&T resources be expended wisely. The objective of the Task Force is to recommend ways in which the allocation of resources to S&T programs can be made more effective.

All three military Services have investment strategies, including time-based technology roadmaps, that plan specific technology endeavors within the context of satisfying near- and far-term mission requirements. DoD scientists and engineers also have a variety of coordinating groups through which they regularly meet and exchange technical information. In addition, DUSD(R&AT) holds yearly S&T Reviews. These, however, have not been completely effective in providing adequate high-level coordination across the whole S&T program. In addition, significant portions of the S&T program are currently outside the purview of DUSD(R&AT), e.g., those of SDI, DARPA, and DNA, and this situation in itself significantly complicates effective coordination.

2. Charter and Participants

The Core Group of the Task Force identified three major areas that need to be addressed to improve coordination of the S&T program: long-range strategic planning, coordination mechanisms, and advocacy for S&T programs. Working groups were chartered to address these areas. This report documents the output from Working Group B, the Program Coordination Group.

The Charter given to Working Group B by the Core Group included the following objective.

To recommend ways in which technical coordination among S&T programs can be improved and bureaucratic coordination can be streamlined.

The Charter also included the following four issues to be addressed at a minimum.

- What coordination mechanisms should be used at OSD and Service levels (include documentation and evaluations of existing mechanisms)?
- How should bureaucracy be minimized in coordination efforts (e.g., paperwork and reporting mechanisms)?
- How should related S&T efforts be coordinated more effectively (e.g., by means of electronic communication, computerized library)?
- Can effectiveness of "mid-level" coordination be improved? Should it?

A complete list of the members of Working Group B is given in Appendix A.

3. Activities

Working Group B met five times between February and June 1988. Discussion at the first meeting of this group focused on the objective and issues assigned by the Core Group. Each issue was delineated and refined, and at the second meeting the group decided to reformulate the issues into three main categories. Subgroups were formed for each category and tasked as follows:

- Subgroup 1 -- Outline of a High Level Coordination Process
- Subgroup 2 -- Identification of Technology Areas for Coordination
- Subgroup 3 -- Evaluation of Existing and Future Coordination Mechanisms.

Each subgroup met and then presented their findings and recommendations to the whole group who reviewed the findings against the original issues. The subgroups further

refined their recommendations, which became the basis for the first draft of the Working Group Report.

The third meeting focused on the further development of the recommendations to present to the Core Group and the incorporation of implementation plans into the draft report. A documented briefing of the findings and recommendations was prepared from the results of this meeting and presented to the Core Group. From the briefings given by the Working Group representatives, the Core Group developed a detailed overview diagram of the proposed process [Figure ES-1 in Volume I]. The fourth meeting of Working Group B began with a discussion of the Core Group feedback on their briefing and the overview diagram. Each subgroup was assigned a number of feedback issues to address and to incorporate appropriate responses into the report. The final meeting was spent on a detailed review of the Working Group recommendations and the finalization of the report. The detailed results of the Group's deliberations are contained in the following sections.

B. ISSUES AND FINDINGS

In discussing coordination issues the Working Group found it useful to distinguish between "technical interchange" for the purposes of information exchange and "programmatic coordination" for the purposes of identifying gaps and overlaps and ensuring the total DoD S&T program is properly addressing the S&T guidance planning goals. In this sense, it appears that technical interchange is already quite extensive and that what is really required is more effective programmatic coordination across the Services and the DoD agencies. The coordination mechanisms currently used for the S&T program are listed in Appendices B, C, D, and E. Appendix B lists the directorates in the DUSD(R&AT) office and the technology areas monitored by each of them. Appendix C gives the coordination groups and panels organized by the Joint Directors of Laboratories as well as their charter and structure. Appendix D gives technology areas where there are formal tri-Service coordination agreements. These cover chemical/biological warfare and medical S&T programs. Appendix E gives a partial list of tri-Service and inter-Agency coordinating groups in alphabetical order. The primary function of many of these groups is technical interchanges.

The Services already have evolved their individual S&T planning and investment strategies into a process that involves Service mission needs, threat projections, and technological developments for the near and long term. Each has developed program plans

and technology roadmaps that are used by DUSD(R&AT). Although technologists at the working level communicate extensively across Services through a multitude of existing technical interchange groups, there is an absence of coordination of the total programmatic information of the Services that can be promulgated to DUSD(R&AT) in a coherent and effective manner. Instead, DUSD(R&AT) via staff specialist currently obtains needed information by holding S&T Reviews. This process does not readily convey a coherent and efficient DoD-wide picture of S&T programs and their management.

1. Need for DoD-Wide S&T Coordination Mechanism

The execution of the S&T program under a strategic plan is seen by the group to consist of (1) guidance which sets forth near- and far-term operational needs, (2) an investment strategy which establishes technology goals to meet these needs, (3) technology programming which lays out time-based technology roadmaps to meet these goals, and (4) allocation of resources to carry out these technology roadmaps. This process is a dynamic one; having established guidance and an investment strategy, the strategic planning function is to solicit feedback from the programming and resource allocation processes in each Service and Agency so as to identify any problems requiring remedial action. This feedback requirement creates a need for the technology programming performed by each of the Services and Agencies to be coordinated across the whole of DoD's S&T activities to ensure that the "corporate" technology goals in the Investment Strategy are being addressed comprehensively and in a timely manner.

a. Advocacy and Accountability

Such a comprehensive view of the S&T program by technology area, relatable to operational needs, would greatly assist DUSD(R&AT) and DDR&E in advocating support for the DoD S&T program to higher levels of DoD management and to Congress. In an era of tighter budgets, such advocacy needs strengthening to defend the S&T program investment in competition with the much larger investment demands of systems already in development. Furthermore, the provision of a coordinated view of S&T programs by technology area with time-based technology development roadmaps would provide a means of tracking accountability at all levels by coupling programs and results to strategic guidance.

The current system does not result in a DoD-wide strategic coordination of the S&T program. There is need for a coordination mechanism with DoD-wide representation to

coordinate technical projects and programs. If possible, this mechanism should be created by modifying or expanding an existing mechanism or group or by combining several mechanisms or groups to represent a comprehensive set of technology areas (clusters) in the S&T program. The DUSD(R&AT) organization should be represented in each of the coordinating groups and participate in the technical reviews.

b. Documentation Requirements

As stated above, data at the Service level exists and is available for supporting the review process. The working group finds no problem with the current documentation capabilities of the Services to provide S&T program data. There does appear to be a need to control data and format growth.

2. Need for Standard Technology Areas

In order to effect S&T programmatic coordination across DoD and communicate this to higher management levels, a need exists to define a set of common technology areas or clusters which are compatible with existing management practice. This is essential to relate the programs in different Services and Agencies in order to:

- minimize bureaucratic problems
- facilitate review and communication throughout DoD
- define a common basis for investment strategy and long-range planning
- define the technologies for transition to notional systems
- provide the basis for structuring the programmatic coordinating mechanism
- provide the basis for DoD cooperative programs and assessments of high-interest technology.

Lists of the technology areas used within the existing infrastructure have been examined by the working group, and no entirely consistent set of technology areas between the Services, OSD, and present coordinating bodies exists at present. A standard set of technology areas is needed.

3. Need for a Streamlining of Current Tri-Service and Inter-Agency Coordinating Groups

A large number of groups exist within and outside the DoD for the purpose of exchanging scientific and technical information. A partial list of these groups is contained

in Appendix E. Despite this vast collection of groups there is general agreement that programmatic coordination needs improvement. Streamlining the information exchange process could be an effective way to improve productivity.

4. Summary

The findings of Working Group B may be summarized as follows:

- There is an abundance of technical interchange at the working levels, but there is a lack of Science and Technology programmatic coordination at higher levels.
- Significant portions of the S&T program are outside the current S&T review process conducted by DUSD(R&AT) (e.g., those of SDI, DARPA, and DNA) and this situation needs to be remedied.
- A programmatic coordination mechanism, including a coherent review process, designed to focus information on the DoD-wide S&T programs, is needed to make sure that resources are being allocated effectively.
- A common set of technology areas or clusters is needed to facilitate coordination on a DoD-wide basis.

In order to address these findings and the other issues directed by the Core Group, Working Group B set out to develop recommendations which would provide:

- (1) a process or mechanism for programmatic coordination across DoD,
- (2) a breakout of technology areas that could be used in the coordination process, and
- (3) an evaluation of the continued usefulness of existing tri-Service and inter-agency coordinating groups if (1) were in place.

The following sections contain the recommendations and implementation plans developed by the working group.

C. POLICY RECOMMENDATIONS

The Secretary of Defense should affirm that it is his plan to strengthen the S&T program by instituting DoD-wide strategic planning for the S&T program. Part of that plan requires programmatic coordination of S&T programs across all DoD Services and agencies. It is recognized that elements of the S&T program do have effective tri-Service program coordination today; however, to effect DoD-wide strategic planning for S&T

programs such coordination is needed for all elements. The following actions are needed to create a comprehensive programmatic coordination process:

1. DoD-Wide Coordination Mechanism

USD(A) should establish a DoD-wide S&T Coordination Group charged with setting up Technology Coordinating Panels (TCPs) for each technology area in the S&T Program and overseeing their operations. In the process of creating these panels the S&T Coordination Group should utilize existing organizational structures, for example, JDL committees and ASBREM, as much as possible.

The Technology Coordinating Panels will be designed to:

- establish accountability for performance based on resource investment
- prevent unwarranted duplication, sub-critical mass resourcing, and general inefficiencies
- identify technology development shortfalls relative to system needs and technological surprise
- provide a forum to ensure S&T information flow between the OSD staff, the Services, DoD agencies (e.g., DARPA) and Initiatives (CDI, BTI, SDI, etc.) to achieve programmatic balance and integration
- ensure technical information exchange makes effective use of computerization and electronic communication techniques.

This mechanism or process is not intended to be used for resource allocation. The Services will still determine their final resource allocations through the existing budgeting system based on feedback from the coordination process and intra-Service priorities.

2. Standard Technology Areas

USD(A) should direct the S&T Coordination Group to adopt the set of 17 Technology Coordinating Panels recommended below in the Action Plan. These areas should be updated as necessary to be consistent with DoD objectives as defined in the DoD-wide S&T Guidance.

The technology areas/clusters will provide the basis for:

- facilitating review and communication throughout DoD
- defining the basis for investment strategy and long-range planning
- defining the technologies for transition to notional systems

- structuring the coordinating mechanism
- assessing high-interest technology and DoD cooperative programs.

3. Streamlining of Coordinating Groups

USD(A) should charter the S&T Coordination Group, after establishing the TCPs, to review other existing coordination groups by:

- establishing criteria for the existence of tri-Service and inter-agency coordinating groups
- evaluating the need for existing groups according to the criteria
- recommending the retention of only those groups that meet the criteria.

D. IMPLEMENTATION PLAN

1. Outline of a Process for Improved Coordination

To effect an overall strategic planning process it is necessary to improve the programmatic coordination of S&T programs across all DoD Services and Agencies. It is recognized that some elements of the S&T program do have effective tri-Service coordination today, but to provide evidence that the Investment Strategy is being carried out it is necessary to extend this coordination across all DoD S&T elements. This requires including other DoD Agencies in currently existing coordination mechanisms and extending the coordination to all S&T technology areas.

There are formal tri-Service agreements on coordination of S&T programs in the medical area and in the chemical/biological area. There are also informal agreements covering the personnel/training and civil engineering areas. For the rest of the S&T programs there are a number of ad hoc coordination groups established by the Joint Directors of Laboratories. Some of these JDL groups have proved effective while others have not; but they were never intended to carry out the formal coordination that is needed to support a strategic planning process.

In addition to these high-level groups, there are a multitude of existing tri-Service and inter-Agency coordination groups. The Task Force identified over 200 such activities (see Section II, Working Group B Report, Appendix F). If a set of high-level TCPs are established, then in the interests of efficiency these group activities should be reviewed to see where redundancies exist.

It appears that to strengthen the current coordination mechanisms the following steps need to be taken:

- (1) Establish a DoD-wide S&T Coordination Group charged with establishing Technology Coordinating Panels (TCPs) for the whole S&T Program. In this process existing coordination mechanisms that are effective should not be replaced, but simply recognized as the official TCP for that area.
- (2) Establish a common set of technology areas for the whole DoD S&T program. Each of these areas should have a TCP.
- (3) Streamline the coordination process by absorbing or replacing existing groups that are not needed to support the work of the TCPs.

The programmatic coordination process that is envisaged is shown in Figure II-1.

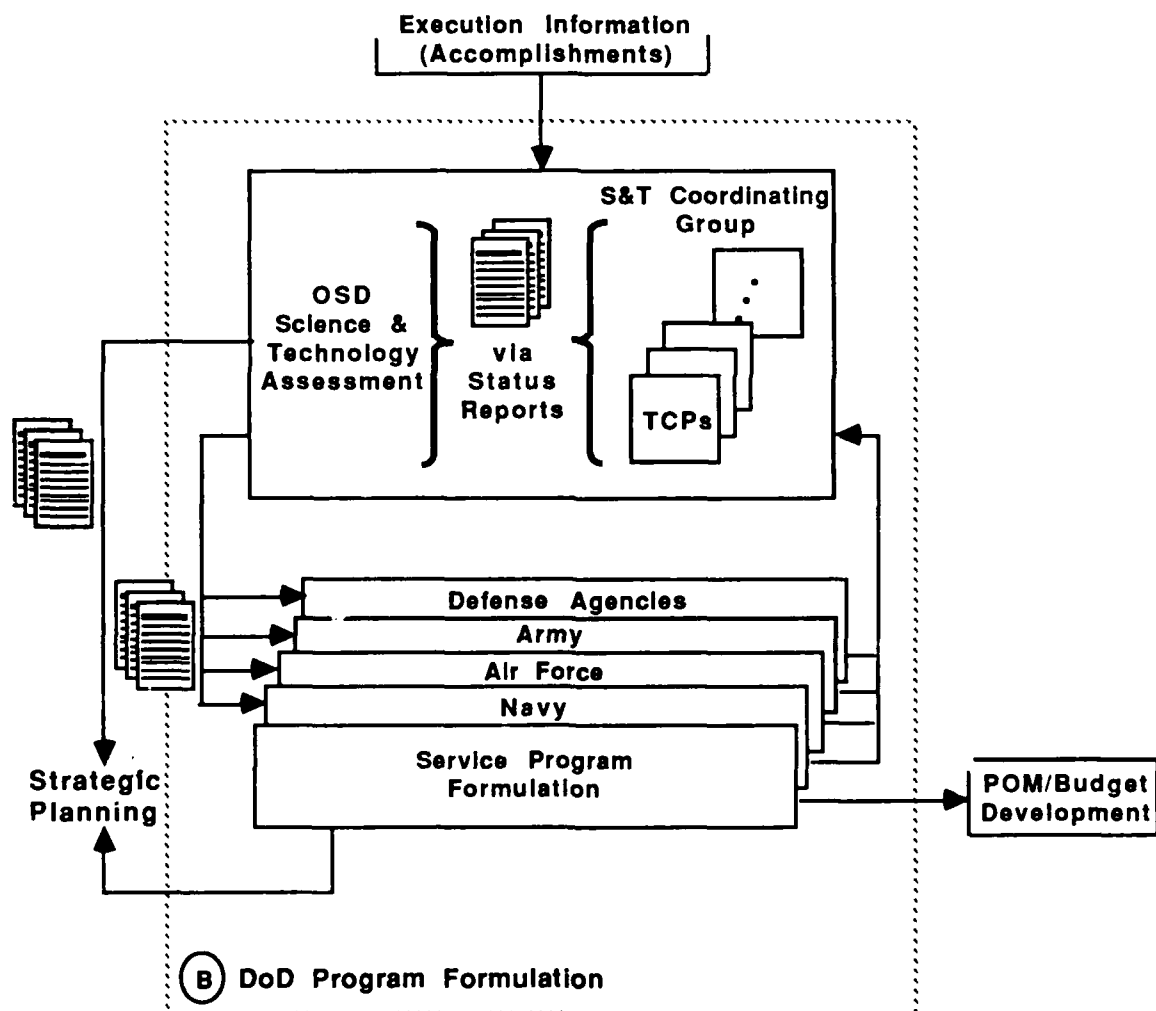


Figure II-1. Process for Coordination of Program Formulation

2. The S&T Coordination Group

Working Group B recommends that the S&T Coordination Group consist of senior representatives from all DoD Services/Agencies involved in S&T Programs, including OSD, DARPA, DNA, and SDIO. The chairmanship of this group will rotate biannually among the Service and Agency members.

The S&T Coordination Group will have three primary responsibilities:

- Establishing the Technology Coordinating Panels (TCPs);
- Reviewing the reports issued by the TCPs and forwarding them to OSD; and
- Adjudicating disputes and ensuring efficient coordination of the TCPs.

The working group also recommends that the technology coordinating panels (TCPs) include representatives from the Services and all other DoD agencies that conduct S&T, such as DARPA, DNA, and SDIO. One technology coordinating panel should be organized for each of the common technology areas proposed below (see Section D.2). These panels should be charged with preparing formal status reports (outlined in Section 2 below) for their technology areas. In preparing these reports the TCPs will use existing data bases and formats of the Services as used by them in their own planning processes. If new formats are required, it will be the responsibility of each Technology Coordinating Panel to do so under the guidance of the S&T Coordination Group.

The TCP panel members will be kept current with the status of the technology, why specific programs are being pursued, and what user needs necessitate pursuit of the technology. Specific technology roadmaps from the Services and other DoD agencies, by common technology area, will be available to each technology coordinating panel for review. Specific programs, technical objectives and approaches, resource allocation by year, and where the technology flows and transitions occur will be included in these roadmaps. With this information, the following issues can be addressed:

- unwarranted technology duplication
- the resources being allocated by technology area, by Service/organization, and by year
- potential technology gaps
- identification of lead times for critical technologies for user needs.

Multi-year comprehensive roadmaps for the technology area will enhance visibility of program changes, show technology slips/terminations due to budget reductions, and

help to reduce year-to-year perturbations from changing priorities/management personnel. These detailed technology roadmaps will form the basis for formal status reports which can be used for investment analyses and advocacy to Congress. These status reports of the panels can be reviewed to determine output vs. resource investment and the rationale for not meeting planned technology transitions.

a. Members and Chair of Technology Coordinating Panels

Membership on the TCPs for each technology area should consist of senior R&D managers in that area from each of the Services and the other DoD agencies that conduct S&T programs, e.g., DARPA, DNA, SDIO. It is important that both DUSD (R&AT) action officers and Service Secretariat staff are participating members of the TCPs. Participation in the panels by DUSD(R&AT) action officers ensures that they obtain first-hand knowledge of each technology area and satisfies the information dissemination function of an S&T Review. The DUSD(R&AT) action officers also have the opportunity to provide information during the TCP deliberations on coordination and review of the technology programs.

The chairperson of each TCP should serve a full-time two-year term and the position should rotate among the Services. To be effective, the duties and authority of the TCP chairperson must not extend to directing programs and Service budget allocations, and should be defined as follows:

- To serve as the spokesperson and single focal point for the technology area, providing a ready access to information on that technology area
- To draw together and structure the top-level data to show that the technology area plan is integrated and that no unwarranted duplication exists
- To show applications for the technology area by mission area
- To articulate why technological advances are being pursued (e.g., evolving threats, Service needs)
- To articulate technology area plans and programs at an integrated level
- To facilitate actions to eliminate unwarranted duplication and assure critical mass resourcing
- To call meetings to review the technology area.

If issues (duplication, gaps, etc.) result from the meetings and cannot be resolved by the participants, these should be raised to the S&T Coordination Group for review and, if still unresolved, forwarded for review by OSD.

b. Output of the Technology Coordinating Panels

Each Technology Coordinating Panel will prepare an annual report on the status of its technology area. This report will discuss the development of the technology, how it is being coordinated, the significant milestones, and the shortfalls. It should contain the following sections:

1. Accomplishments

A listing of the accomplishments (significant technological breakthroughs).

2. S&T Strategy

A description of how the technology area fits into the DoD investment strategy goals and objectives.

3. Technology Roadmap

A time-based discussion of how the technology objective will be developed and an outline for feedback for accountability assessment.

4. Current Technology Program

A discussion of how the program is being developed and funded, showing how the Service and DoD agency programs are being integrated into the overall program, including future plans, and a revisit to the issues from prior years for providing feedback for accountability.

5. Shortfalls

Identification and discussion of unfunded emerging technologies and underfunded existing programs.

6. Issues

a. Issues Solved

b. Outstanding Issues

Identification of coordination elements in disagreement and large-scale duplication

7. Competitive Technology Assessments

Discussion of the state of US technology (Industry, IRAD, etc.) in the area covered by the panel, and the state of the allies'/adversaries' technology.

8. Summary

c. Science and Technology Data Base

The information required for the review process to be undertaken by the TCPs was discussed above. However, to have effective technical coordination of the S&T Program, S&T technical information must be available to the full DoD community in a timely manner. This may require the creation of a data base similar to that utilized for large weapon system development programs. The development of this type of system is beyond the scope of this task force, but it is an important effort that should be undertaken. It is recommended that any development of an S&T data base include the Defense Technical Information Center and the Information Analysis Centers' participation.

3. Identification of Technology Areas for Coordination

The Working Group has identified a set of 17 technology areas that covers the whole S&T program. In arriving at this list a compromise was sought among:

- The existing technology area divisions in the Directorate of DUSD(R&AT) (see Appendix B).
- The existing subcommittees of the Joint Directors of Laboratories (see Appendix C).
- The existing technology areas defined by the Services and Agencies, to the extent they were known by members of the Working Group.

The 17 technology areas are listed below. Some are Service unique, such as the Ships and Submarines or Tank and Automotive areas; others have assigned lead Service responsibility, such as Medical or Chemical and Biological Warfare Defense (Appendix D); and, finally, the remaining areas are of interest to all three Services and therefore should be areas of emphasis for coordination. In the list below some of the specific technologies comprising the technology area are given for clarification, but they do not represent a complete subset.

These 17 technology areas do not completely correspond to any existing technology area structures. As noted above both the Medical area and the Chemical and Biological Warfare Defense area are already covered by formal Joint Service Agreements (see Appendix D). Also, existing JDL technology coordinating groups on C³I, EW, Advanced Materials, and Computers technology areas appear to correspond directly to the proposed technology areas (see Appendix C). Any list of standard technology areas will have to be reviewed periodically in conjunction with the goals and objectives of the DoD Guidance, and areas will have to be added to or removed from the list as required. The working

group recommends that the S&T Coordination Group use this list in establishing its TCPs, modifying it only as necessary.

1. Chemical and Biological Warfare Defense
2. Environmental Science and Quality
 - Atmospheric
 - Terrestrial
 - Space
 - Oceanography
 - Hazardous and Toxic Materials
3. Materials and Structures
 - Structural Materials
 - System Materials
 - Non-Destructive Testing
 - Joining/Fabrication
4. Personnel and Training
 - Manpower and Personnel
 - Education and Training
 - Simulation and Training Devices
 - Human Factors
5. Ships and Submarines
 - Hulls
 - Hydrodynamics
 - Machining
6. Propulsion
 - Air Breathing
 - Rockets
7. Tank/Automotive
 - Armor
 - Power Plant
8. Aerodynamic Structures
9. Weapons and Munitions
 - Conventional Munitions
 - Directed Energy

10. Life Sciences
 - Life Support Systems
11. Civil Engineering
 - Airfields/Pavements
 - Quality Assurance
 - Facilities
12. Logistics
 - Material Supply
 - Distribution
 - Control
13. Surveillance, Reconnaissance, and C³I
 - Communications
 - Control and Command
 - Navigation
 - Intelligence
 - Undersea
 - Space
 - Surface
 - Air
14. Electronic Devices and Avionics
 - Radio Frequency/Microwave/Millimeter Wave
 - Avionics
 - Control Components
 - Electrical Materials
15. Computers and Software
 - Software
 - Artificial Intelligence
 - Robotics
 - Architecture
16. Electronic Warfare
17. Medical.

4. Evaluation of Existing and Future Coordinating Groups

The objective of evaluating coordinating groups already in existence (or those which might be formed in the future) is to have the *minimum* number of coordinating

groups required for providing information to each Technical Coordinating Panel for preparation of the formal report described above. The proposed process is as follows.

1. Each Technology Coordinating Panel establishes the number of technology sub-panels it requires to develop the information for its formal report. This process should include an evaluation of the existing coordinating groups on their capability to provide the information required. This process may also identify new technology sub-panels that may be required.
2. Each sub-panel in turn would evaluate the existing coordinating groups to determine the minimum number required to provide its information set. Again, the need may be identified for new coordinating groups or for the alteration of existing groups.
3. Existing coordinating groups examined by the processes in 1 and 2 above would be subject to the "One-by-One" Evaluation Approach in which the questions listed below are to be considered in evaluating each group. Findings and recommendations to disestablish a coordinating group would be forwarded to the agency or office that chartered that particular group.
 - Who established this coordinating mechanism?
 - Why was it established? Its purpose?
 - Is the purpose still valid?
 - What is its output?
 - Who receives its output?
 - Does the output support the process defined by Subgroup 1?
 - Is the output useful to those who receive it?
 - Who is the proponent of the mechanism?
 - Who is responsible for abolishing the mechanism?
 - What would not happen if this mechanism would be abolished?
 - Could it be combined with another mechanism?
 - When was its existence last reviewed?
4. Standardization and specification coordinating groups are excluded from this process, as are groups strictly devoted to technical interchange.

Appendix A

WORKING GROUP B LIST OF MEMBERS

WORKING GROUP B LIST OF MEMBERS

- | | |
|---|--|
| <ul style="list-style-type: none"> • Dr. Budd B. Adams
Head, Exploratory Development Group
Naval Ocean Research and Development Activity
Code 113
NSTL, MS 39529-5004 | Telephone: (601) 688-4720
Autovon: 485-4720 |
| <ul style="list-style-type: none"> • Mr. James Burda
Chief, Plans & Programs Div
Air Force Armament Laboratory
AFATL/XP
Eglin AFB FL 32542-5434 | Telephone: (904) 882-2205
Autovon: 872-2205 |
| <ul style="list-style-type: none"> • Dr. James Bynum
Chief, Plans, Programs and Operations
US Army Research Institute for the Behavioral
and Social Sciences
5001 Eisenhower Avenue
Alexandria VA 22333-5600 | Telephone: (202) 274-8637
Autovon: 284-8637 |
| <ul style="list-style-type: none"> • Col. Harry G. Dangerfield
Executive Assistant to the PEO for Health
Care Systems
Fort Detrick
Frederick MD 21701-5012 | Telephone: (301) 663-7443
Autovon: 343-7443 |
| <ul style="list-style-type: none"> • Dr. Genevieve Haddad
Tech Director, Combat Support
DCS Technology and Plans
HQ AFSC/XTH
Andrews AFB MD 20334-5000 | Telephone: (301) 981-3342
Autovon: 858-3342 |
| <ul style="list-style-type: none"> • Mr. David R. LaRoche
Chief, Plans & Programs Branch
Technical Plans and Operations Office
Air Force Geophysics Laboratory
AFGL/XOP
Hanscom AFB MA 01731-5000 | Telephone: (617) 377-3606
Autovon: 478-3606 |
| <ul style="list-style-type: none"> • Dr. John MacCallum, R&AT
Director, Electronic Systems Technology
The Pentagon, Room 3D359
Washington DC 20301-3080 | Telephone: (202) 693-2978
Autovon: 223-2978 |

- Mr. William Noll, R&AT
Staff Specialist, Laboratory Management
The Pentagon, Room 3D367
Washington DC 20301-3080

Telephone: (202) 694-0205
Autovon: 224-0205
- Dr. Lawrence J. Puckett
Associate Director
US Army Ballistic Research Laboratory
Aberdeen Proving Ground MD 21005-5006

Telephone: (301) 278-6244
Autovon: 298-6244
- Dr. Richard Schaffer
Technical Director
Construction Engineering Research Laboratory
Champagne IL 61820

Telephone: (217) 373-7202
- Mr. Glenn Spalding
Director, Support Technology Directorate
Office of Naval Technology
800 N. Quincy Street
Arlington VA 22217-5000

Telephone: (703) 696-4791
Autovon: 226-4791
- Dr. Richard C. Sorenson
Associate Technical Director
Navy Personnel R&D Center
Building 329
San Diego CA 92152-6800

Telephone: (619) 553-7814
Autovon: 553-7814
- Mr. George Taylor
Associate for Technology & Engineering, AED
Armament Research, Development, and
Engineering Center
Picatinny Arsenal, Bldg 1, 3d Floor
Dover NJ 07801-5001

Telephone: (201) 724-4656
Autovon: 880-4656
- Mr. Wilbert J. Uhl
Chief, Air Force Wright Aeronautical
Laboratory Plans Office
AFWAL/XR
WPAFB OH 45433

Telephone: (513) 255-5953
Autovon: 785-5953
- Dr. Arno K. Witt
Technology Base Manager
Code 01B
Naval Air Development Center
Warminster PA 18974

Telephone: (215) 441-1064
Autovon: 441-1064

Appendix B

DUSD(R&AT) ORGANIZATION

DUSD(R&AT) ORGANIZATION

The Office of the Deputy Under Secretary of Defense (R&AT) is organized into directorates under the following 25 technology areas:

Research and Lab Management Office -- Ted Berlincourt, Director

Research

Engineering Technology Office-- Raymond F. Siewert, Director

Aeronautical Vehicle Technology

Aircraft Propulsion Technology

Land Mobility Technology

Ocean Vehicle Technology

Tactical Missiles Guidance and Control Technology

Propulsion Technology for Missiles and Space Vehicles

Torpedoes and Other Underseas Warfare Weaponry Technology

Guns

Bombs and Clusters

Landmines, Landmine Countermeasures and Barriers

Materials and Structures

Electronic Systems Technology Office -- John MacCallum, Director

Directed Energy Technology

Electronic Warfare

Search and Surveillance

Target Acquisition and Fire Control

Communications

Command and Control Technology

Computers and Electronic Technology Office -- E. D. Maynard, Jr., Director

Electronic Devices

Computers and Software Technology

Environmental and Life Sciences Office -- Thomas R. Dashiell, Director

Chemical Warfare and Chemical Biological Defense Science and Technology

Environmental Sciences

Environmental Quality Research and Development

Training and Personnel Systems Technology

Medical and Life Sciences

Appendix C

JDL ORGANIZATION

JOINT DIRECTORS OF LABORATORIES (JDL) ORGANIZATION

<u>LEAD SECRETARIAT:</u>	OPNAV <u>OPR:</u> CNR	- RAdm J. R. Wilson, Jr. *226-4258
<u>ESTABLISHED:</u>	11 Dec 1973 OPNAV/SPAWAR-005	- Mr. Jerry L. Reed *222-2766
<u>CHARTERED:</u>	11 Dec 1973 AFALC/CC	- MG(SEL) J. K. Spiers *785-6314
<u>RECHARTERED:</u>	31 Mar 1982 AFSC/XT 20 Jun 1984	- BG C. F. Stebbins *858-5416

MISSION: To identify and recommend for implementation those Joint endeavors which will maximize the efficient utilization of technology-based resources and promote increased inter-Service dependence.

MEMBERS:

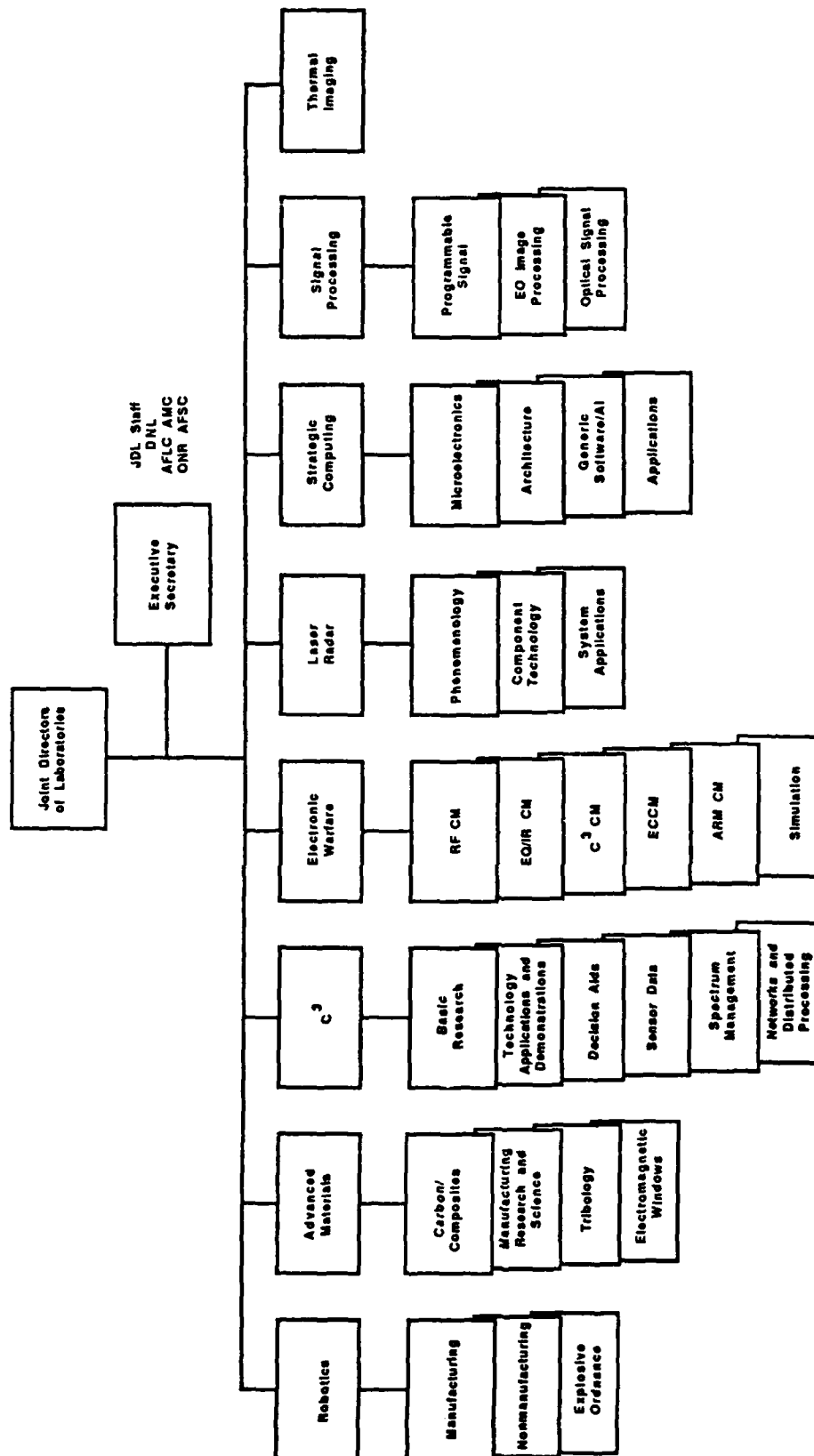
AMC:	BG M. R. O'Neill Mr. Allan Barrick	AMC/HQ LABCOM AMC/HQ LABCOM	*290-1600 *290-3557
Navy:	Mr. Jerry L. Reed Mr. Mike Marshall	SPAWAR-005 NSWC/D28	*222-2766 *249-7865
AFLC:	MG(SEL) S. K. Spiers LTC Clint Allison	AFLC/CC AFLC/MM	*785-6314 *787-6202
AFSC:	BG. C. F. Stebbins LTC Chris Lind	AFSC/XT AFSC/XT	*858-7174 *858-4215
CNR:	RAdm J. R. Wilson, Jr.	CNR	*226-4258
Executive Secretary - CDR Mike Gahl		CNR/1224	*226-4713

*AUTOVON

The JDL, one of the coordinating groups of the Joint Logistics Commanders, consists of five principals: The AFSC Deputy Chief of Staff for Technology and Plans; The Commander, Air Logistics Center, AFLC; The Director of Navy Laboratories; The Chief of Naval Research; and the Deputy Chief of Staff for Technology Planning and Material, U.S. Army Material Command. The purpose of the JDL is to optimize utilization of the Technology Base and Laboratory Resources for promoting coordination actions among the Services in S&T Program Planning, Review and Cross-Fertilization of Service Funding, Expertise and Facilities.

The JDL uses several types of subgroups staffed by senior personnel, usually at Laboratory Technical Director or Chief Scientist level. Currently, there are eight technology panels covering areas having applications for all Services. These panels are tasked to develop tri-Service cooperative programs, foster joint use of technology base resources, establish coordinating mechanisms and management structures, and address unique issues. They report to the JDL semi-annually.

In addition, the JDL has Technical Initiatives Panels to address specific issues over some specified time period and ad hoc groups to conduct tri-Service reviews of high interest technology areas such as light armor, millimeter wave communications, and welding/joining.



Note: Panels/Committees/Groups are reviewed periodically. Organizations may be added or deleted based upon need.

Figure C-1. Joint Directors of Laboratories Organization

DEPARTMENT OF THE ARMY
HEADQUARTERS UNITED STATES ARMY
MATERIEL DEVELOPMENT AND READINESS COMMAND
5001 EISENHOWER AVE., ALEXANDRIA, VA. 22333



DEPARTMENT OF THE NAVY
HEADQUARTERS NAVAL MATERIAL COMMAND
WASHINGTON, DC 20360

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE LOGISTICS COMMAND
WRIGHT-PATTERSON AFB, OHIO 45433

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE SYSTEMS COMMAND
ANDREWS AFB, WASHINGTON, DC 20334

CHARTER FOR
JOINT DARCOM/NMC/AFLC/AFSC COMMANDERS
JOINT DIRECTORS OF LABORATORIES (JDL)

I. PURPOSE

The purpose of the Joint Directors of Laboratories (JDL) is to optimize the efficient utilization of technology base and laboratory resources, which will result in the highest return on investments achievable through cooperative actions in program planning, reviews and assessments, and cross-fertilization of in-house funding, expertise and facilities.

II. MISSION

A. Develop and guide technology programs of multi-service interest which have the highest potential payoffs and widespread utility. Take appropriate actions and promote or recommend programmatic decisions or recommendations based on program planning which:

1. Identifies critical areas of technology.
2. Determines what gaps need to be filled.
3. Identifies areas for de-emphasis, of marginal utility, or of unwarranted duplication.
4. Recommends priorities and funding requirements.
5. Examines impact on facilities, personnel and equipment.

B. Determine practicality and desirability of establishing tri-service high technology centers or institutes to conduct basic and applied research in specific technologies of common interest to all services.

1. Examine individual service facilities, equipment and capabilities.
2. Examine capabilities external to the services and the potential for coupling with the services.
3. Recommend to the Joint Logistics Commanders the establishment of tri-service centers or institutes where desirable.

C. Annually assess JDL activities and report recommendations to the Joint Logistics Commanders.

III. MEMBERSHIP

A. The principal members of the JDL shall be the following (or their designated representatives):

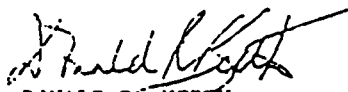
AFLC	Director, Acquisition Logistics
AFSC	Deputy Chief of Staff for Science and Technology
DARCOM	Assistant Deputy for Science and Technology
NMC	Director of Navy Laboratories and Deputy Chief of Naval Material (Technology)

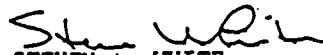
B. The principal members of the JDL will designate their alternate members and staff.

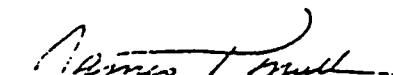
C. Chairmanship will rotate among the Services as determined by the JDL principals.


D. The Chairman will provide a full-time Executive Secretary to support and assist the JDL.

E. Subpanels and subgroups of the JDL may be established as required. These groups will normally include at least one member from each Service. Other government agencies may have representatives who will be considered invited participants.


DONALD R. KEITH
General, USA
Commander
US Army Materiel Development
and Readiness Command


STEVEN A. WHITE
Admiral, USN
Chief of Naval Material
Naval Material Command


JAMES P. MULLINS
General, USAF
Commander
Air Force Logistics Command


ROBERT T. MARSH
General, USAF
Commander
Air Force Systems Command

DATE: 20 JUNE 1984

Appendix D

**TRI-SERVICE COORDINATION OF S&T PROGRAMS
IN SPECIAL SUPPORT AREAS**

Chemical/Biological Warfare Defense.....	II-D-1
Medical.....	II-D-11

DEPARTMENT OF THE ARMY
OFFICE OF THE SECRETARY
WASHINGTON, D.C.

DEPARTMENT OF THE NAVY
OFFICE OF THE SECRETARY
WASHINGTON, D.C.

DEPARTMENT OF THE AIR FORCE
OFFICE OF THE SECRETARY
WASHINGTON, D.C.

JOINT SERVICE AGREEMENT

Subject: Joint Service Coordination of Chemical Warfare and
Chemical-Biological Defense Requirements, Research, Development,
and Acquisition

Reference: DOD Directive 5160.5, "Responsibilities for Research, Development,
Test and Evaluation (RDTE) on Chemical Weapons and Chemical Biological
Defense" dated 30 March 1976.

1.0 PURPOSE AND OBJECTIVE.

1.1 The purpose of this Agreement is to prescribe procedures for
coordinating the Services' chemical warfare and chemical-biological defense
(CW/CBD) requirements and research, development, and acquisition (RDA)
programs.

1.2 The objective of this Agreement is to assure that the Services
conduct coordinated CW/CBD RDA programs to meet, within the constraints of
resources available, the highest priority requirements of all the Services and
the goals of the Defense Guidance.

2.0 APPLICATION AND SCOPE.

2.1 This Agreement supersedes the Joint Service Agreement on CW/CBD
Research, Development, Test, and Evaluation (RDTE) dated 20 June 1977.

2.2 The provisions of this Agreement apply to the DOD components (as
defined in DODD 5160.5) responsible for establishing military requirements and
planning, programing, budgeting, funding, and executing CW/CBD RDA.

2.3 This Agreement establishes policies and provides an overview of
the joint CW/CBD requirements and RDA program coordination process. Detailed
implementing procedures are at Annex A (Implementation Procedures) to this
Agreement. Procedures for transitioning from the 20 June 1977 Joint Service
Agreement on CW/CBD RDTE to this Agreement are at Annex B (Transition Plan).

2.4 This Agreement includes chemical lethal and incapacitating
agents and their delivery systems; chemical-biological (CB) decontamination;
CB detection, identification and warning; individual CB protective items and
clothing; CB collective protection; medical CB prophylaxis and treatment for

CB casualties; CB training devices and simulants; and the general CB threat assessment. While not part of the CW/CBD program, this Agreement also includes riot control agents and herbicides and their delivery systems.

3.0 OVERVIEW.

3.1 The procedures prescribed in this Agreement establish a joint coordination process which is to be integrated with each Service's planning, programing, budgeting, and execution system (PPBES) process.

3.2 The joint process is first used to prepare and recommend to the Services a DOD-wide master plan for CW/CBD RDA. The plan contains the CW/CBD requirements of all the Services, indicates which Services will participate in and have agreed to assume lead roles for each requirement, and considers fiscal and programing guidance. Once approved by the Services, the plan provides a basis for each Service to determine what support to expect from each of the other Services and to plan for addressing those requirements for which the Service has agreed to assume the lead. Each Service then follows its own PPBES process and procedures to address those requirements for which the Service has the lead.

3.3 The joint process is next used to allow the other Services to review each Service's progress. These reviews are performed prior to RDA program execution and provide a means of identifying and attempting to resolve interservice differences over how a Service intends to execute those responsibilities it agreed to accept. Following the review and resolution of interservice differences, each Service, using its own procedures, executes RDA programs for which the Service has the lead.

4.0 DEFINITIONS.

4.1 Materiel developer lead Service: The Service which has agreed to formulate and execute an RDA program addressing a specific requirement.

4.2 Requirement developer lead Service: The Service which has agreed to formulate and obtain approval of the requirement document(s) addressing a specific requirement and develop training programs needed to support fielding.

4.3 Participating Service: A Service which has formally expressed its intent to participate in a Joint RDA program to the other Services; for a requirement being addressed by a 6.3B or 6.4 RDA program, has signed the requirement document; and, where appropriate, has planned and programed for testing and procurement of materiel.

5.0. POLICY.

5.1 The Military Departments herein agree to conduct their CW/CBD programs so as to meet their responsibilities set forth in DODD 5160.5 and coordinate their CW/CBD military requirements, systems characteristics, and RDA programs using the procedures prescribed in this Agreement and in Annex A to this Agreement.

5.2 The Department of the Army (DA) will be the DOD Executive Agent for the DOD CW/CBD RDA program. As the Executive Agent, the DA will take the lead in coordinating the CW/CBD requirements and RDA programs of the Services.

5.3 Responsibilities for CW/CBD RDA are as follows:

5.3.1. The DA, as DOD Executive Agent and lead Service, plans, programs, budgets, funds, and executes CW/CBD research, exploratory development, advanced development, and engineering development for Army requirements, joint requirements of the Army and one or more of the other Services, and all chemical agents for military purposes.

5.3.2. Military Departments other than the DA plan, program, budget, fund and execute CW/CBD research, exploratory development, advanced development, and engineering development for Service unique requirements; when designated as the materiel developer lead Service, for joint requirements involving themselves and one or more of the other Services other than the Army; and as necessary to utilize a unique capability or when DA cannot provide the required RDTE.

5.3.3. Each Military Department plans, programs, budgets, and funds for all procurement of CW/CBD materiel to meet its own requirements. Except as noted below, each Military Department executes all procurement of CW/CBD materiel to meet unique Service requirements. In the case of procurement of CW/CBD materiel to meet the joint requirements of two or more Services, the materiel developer lead Service will normally execute the procurement program for all interested Services. Designated items will be procured for the Services by the Defense Logistics Agency.

5.4 To minimize duplication of CW/CBD RDA capabilities, each Service will make maximum use of the other Services' CW/CBD RDA capabilities. Each Service will, when the required capability does not exist within the Service and is available from another Service, request the other Service perform the required RDA. Each Service will, in turn, be responsive to other Services' requests for the conduct of CW/CBD RDA on their behalf. RDA performed by a Service at the request of another Service will be funded by the requesting Service. In the event the RDA is being performed at the request of two or more Services, the DA, if it is one of the requesting Services, will program, budget, and fund the RDTE. Otherwise, the Service with the primary interest in the requirement will program, budget, and fund the RDTE.

5.5 A Joint Service Review Group (JSRG) will oversee the coordination of the Services' CW/CBD programs. The JSRG will review the entire program on an as required basis and will make recommendations, as appropriate, to the Military Departments.

5.6 Each Service will continue to be responsible for establishing requirements for and determining the system characteristics of CW/CBD materiel for its use. Each Service will provide its CW/CBD requirements to the JSRG.

5.7 The JSRG will formulate and recommend to the Services, a Joint CW/CBD RDA Plan which: identifies and recommends priorities for the CW/CBD requirements of all the Services; recommends the requirement and materiel developer lead Service(s) for each requirement; indicates which Services will participate in and key milestones for each requirement; and considers fiscal and programing guidance to insure that, within the constraints of resources available, the highest priority CW/CBD needs of all the Services are met.

5.7.1 Once approved by the Services, the Joint CW/CBD RDA Plan will be provided to each Service as a basis for the Services' planning, programing, budgeting, and RDA program formulation.

5.7.2 A single Service will normally have the lead for each requirement in order to facilitate maintaining accountability and unity of effort.

5.8 OSD guidance on the implementation of this Agreement will be provided through the Defense Guidance, Program Decision Memorandum, and Program Budget Decision processes as each Service implements those portions of the Joint CW/CBD RDA Plan for which it has accepted responsibility. Information copies of the Joint CW/CBD RDA Plan will be provided OSD as background for its reviews of the Services' programs.

5.9 On approval of the Joint CW/CBD RDA Plan by the Services, each Service will, using its own procedures and within the constraints of resources available:

5.9.1. Be responsive to other Services' requirements and priorities for CW/CBD RDA as reflected in the Joint CW/CBD RDA Plan.

5.9.2. Conduct CW/CBD RDA programing and budgeting in accordance with Service policies and regulations and the provisions of this Agreement. Each Service will maintain direct coordination with the other Services and keep them advised of program or budget reductions affecting joint requirements. If differences exist over the application of program or budget reductions, a special JSRG meeting may be called to recommend alternatives.

5.9.3. Formulate a planned RDA program addressing the CW/CBD requirements for which it is the materiel developer lead Service. RDA programs will be formulated so as to achieve the earliest possible fielding commensurate with Joint CW/CBD RDA Plan priorities, technological risk, and resources available.

5.9.4. Develop and obtain approval of requirement documents for each CW/CBD requirement for which the Service is the requirement developer lead Service. Requirement documents must be concurred in by all participating Services.

5.9.5 Develop and obtain approval of training programs in support of systems for which the Service is the requirement developer lead Service.

5.10 Prior to and during the execution of planned RDA programs, each Service will participate in joint reviews of its CW/CBD requirement documents and training programs preparation, programing and budgeting, and RDA program formulation efforts.

5.11 Following the resolution of interservice differences, each Service will, within the constraints of resources available, execute an RDA program addressing the CW/CBD requirements for which it is the materiel developer lead Service. Each lead Service will ensure that other participating Services are consulted on all major RDA program changes prior to implementation of the change.

6.0 INTERSERVICE LIAISON.

Each Service will provide a Service Headquarters single focal point of contact for the purpose of interservice coordination of all aspects of the implementation of this Agreement to insure that proper consideration is given to Service requirements, priorities, doctrine, training, logistical support, testing, programing, and budgeting.

7.0 IMPLEMENTATION AND REVISIONS.

7.1 This Agreement becomes effective upon signature of all of the Department Assistant Secretaries (R&D).

7.2 This Agreement will be reviewed by the Army, Navy, and Air Force and revised as required. The Annex to this Agreement will be reviewed by the JSRG and revised as required.



J. R. Sculley
Assistant Secretary of the Army
(Research, Development and Acquisition)



Melvin R. Paisley
Assistant Secretary of the Navy
(Research, Engineering and Systems)



Thomas E. Cooper
Assistant Secretary of the Air Force
(Research, Development and Logistics)

Dated: 5 July 1984



Department of Defense DIRECTIVE

May 1, 1985

NUMBER 5160.5

USDR&E

SUBJECT: Responsibilities for Research, Development, and Acquisition of Chemical Weapons and Chemical and Biological Defense

- References:**
- (a) DoD Directive 5160.5, "Responsibility for Research, Development, Test and Evaluation (RDT&E) on Chemical Weapons and Chemical and Biological Defense," March 30, 1976 (hereby canceled)
 - (b) DoD Directive 5000.1, "Major System Acquisitions," March 29, 1982
 - (c) DoD Directive 5000.3, "Test and Evaluation," December 26, 1979
 - (d) DoD Instruction 5000.2, "Major System Acquisition Procedures," March 8, 1983
 - (e) through (i), see enclosure 1

A. REISSUANCE AND PURPOSE

This Directive reissues reference (a) to reflect national policy decisions; update budgeting, and programing and operational procedures; and assign responsibilities for DoD research, development, and acquisition (RDA) of weapons and chemical and biological defense.

B. APPLICABILITY AND SCOPE

1. This Directive applies to the Office of the Secretary of Defense, the Military Departments, the Organization of the Joint Chiefs of Staff, the Unified and Specified Commands, and the Defense Agencies (hereafter referred to collectively as "DoD Components"). The term "Military Service," as used herein, refers to the Army, Navy, Air Force, and Marine Corps.

2. Its provisions encompass the directing, administering, and performing of RDA on chemical weapons and chemical and biological defense (CW/CBD). The management principles expressed in DoD Directives 5000.1 and 5000.3 and DoD Instruction 5000.2 (reference (b), (c) and (d)) are to be applied to all programs addressed herein.

C. POLICY

It is the policy of the Department of Defense to conduct coordinated CW/CBD programs to meet, within the constraints of resources available, the highest priority requirements of the Military Services. This coordination shall include military requirements, system characteristics, and RDA programs of weapons and chemical and biological defense.

D. RESPONSIBILITIES

1. The Secretaries of the Military Departments shall:

a. Establish requirements and determine the military characteristics of chemical deterrent items and chemical and biological defense items for their Department's particular use.

b. To minimize duplication of CW/CBD RDA capabilities, make maximum use of the other Military Departments' CW/CBD RDA capabilities, when required capabilities do not exist within that Military Department and are available from another Military Department. Military Departments will in turn, be responsive to the other Military Departments' requests for the execution of CW/CBD RDA on their behalf, in order to optimize DoD research, development, test, and evaluation (RDT&E) capabilities.

c. Within the programing, budgeting, and funding procedures established in the DoD 7110.1-M (reference (e)), be responsible for the preparation of RDT&E program proposals, budget estimates, and funding requests other than the Department of the Army for all RDT&E programs (6.1-6.4) for their own Department-unique requirement or, when designated the RDT&E lead Military Service, the joint requirements of the Military Department and one or more of the other Military Services.

d. Be responsible for all procurement of CW/CBD materiel to meet its own requirements.

2. The Department of the Army shall:

a. Be the DoD Executive Agent for the DoD CW/CBD RDA program. As the Executive Agent, the Department of the Army shall take the lead in coordinating the CW/CBD requirements and the RDA programs of the Military Services.

b. Within the programing, budgeting, and funding procedures established in the DoD 7110.1-M (reference (e)), be responsible for the preparation of RDT&E program proposals, budget estimates, and funding requests for all RDT&E (6.1-6.4) for Army-unique requirements, the joint requirements of the Army and one or more of the other Military Services, and for development of all chemical agents for military purposes.

c. Operating as the DoD Executive Agent and in coordination with the other Military Departments, prepare the annual report required by 50 U.S.C. Section 1511 (reference (f)) on funds obligated in the chemical and biological warfare program. The report shall include a separate section on the use of human subjects for the testing of chemical or biological agents. The report shall be provided to the Under Secretary of Defense (Research and Engineering) by 1 December of each year.

Z. INFORMATION REQUIREMENTS

The Fund Obligation for Chemical and Biological Warfare is assigned Reports Control Symbol DD-DDR&E(A)1065 in accordance with reference (g).

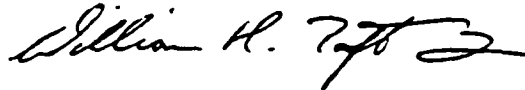
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F. RELATIONSHIP WITH OTHER FEDERAL AGENCIES

Nothing contained herein is intended to modify the existing assignment of responsibilities for the development and execution of national emergency plans and programs as they pertain to defense against biological and chemical warfare, as specified in Executive Orders 11490 and 12148 (reference (h) and (i)).

G. EFFECTIVE DATE AND IMPLEMENTATION

This Directive is effective immediately. Forward two copies of implementing documents to the Under Secretary of Defense (Research and Engineering) within 120 days.



William H. Taft, IV
Deputy Secretary of Defense

Enclosure - 1
References

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REFERENCES, continued

- (e) DoD 7110.1-M, "Budget Guidance Manual," authorized by DoD Instruction 7110.1, October 30, 1980
- (f) Title 50, United States Code, Section 1511
- (g) DoD Directive 5000.19, "Policies for the Management and Control of Information Requirements," March 12, 1976
- (h) Executive Order 11490, "Assigning Emergency Preparedness Functions to Federal Departments and Agencies," October 30, 1969
- (i) Executive Order 12148, "Federal Emergency Management," July 20, 1979

MEDICAL

Armed Services Biomedical Research Evaluation and Management Committee (ASBREM)

In recognition of the continuing need to facilitate management coordination, improve information exchange, and accomplish biomedical RDT&E activities pertinent to their missions, the Army, Navy, and Air Force agree to meet annually and more frequently, as required, in joint session as members of an Armed Services Biomedical Research Evaluation and Management (ASBREM) Committee. The Commander of the Army Medical R&D Command (AMRDC), the Commander of the Air Force Aerospace Medical Division (AMD), and the Special Assistant to the Surgeon General of the Navy for Research and Development are the principals.

Four objectives serve to direct the activities of the committee. These are:

- (a) To increase the cost effectiveness of resource utilization through effective use of personnel, intelligence, facilities, equipment, supplies and services.
- (b) To provide mechanisms to address organizational roles, conduct management skills, and resolve Service organizational/functional alignment issues.
- (c) To ensure program relevance and obviate duplication of Services' and other agencies' programs through timely review of requirements and program plans.
- (d) To define Service issues which require resolution/coordination with other Federal agencies.

Support of the ASBREM is organized accordingly:

- (a) The following Joint Technology Coordinating Groups (JTCG) are established for each of the major biomedical R&D thrust areas:

- Military Dentistry
- Military Infectious Diseases
- Medical Biological Defense
- Combat Casualty Care
- Medical Chemical Defense
- Systems Biotechnology
- Ionizing Radiation Bioeffects.

The groups will be composed of biomedical research managers from the respective Services and key laboratory personnel as appropriate. They are charged with reviews and coordination keyed to the planning, programming, and budgeting cycles of each Service, and recommending changes in program directions or emphasis, new initiatives and other matters dealing with program requirements and relevance.

- (b) A joint Secretariat is established, composed of a personal representative of each Service's ASBREM member. The Secretariat is to be responsible for the conduct of committee and group meetings. It will maintain appropriate records and organize the resources required to carry out the ASBREM decisions.

Appendix E

**PARTIAL LIST OF TRI-SERVICE AND INTER-AGENCY
COORDINATING GROUPS**

PARTIAL LIST OF TRI-SERVICE AND INTER-AGENCY COORDINATING GROUPS

Ad Hoc Interagency Committee for Commercial Satellite Data Acquisition
Advisory Group on Electron Devices (Microwave Devices WG, Microelectronics WG,
Electro-Optics WG, Production WG)
Aeronautical Flight Technology Research Activities Coordinating Group
AF/NASA Interdependency Working Group on Space and Aeronautics
AGARD
Air Force Symposium on Interaction of Nonnuclear Weapons
Air Standardization Coordinating Committee
Annual Tri-Service Review for Atmospheric Transmission R&D
Annual Tri-Service Science and Technology Review
Armed Services Biomedical Research Evaluation and Management Committee (ASBREM)
Army Executive Service
Army Pavement and Railroad Maintenance Committee
Automatic Target Recognition Working Group, Tri-Service
Ballistic Missile and Space System Physical Vulnerability Panel (BMSSPVP)
Battlefield Laser Panel (Joint Logistics Commanders)
Chicken Little Program, Office Steering Committee (*Chicken Little*)
Committee for Space Environmental Forecasting
Committee on Materials - Office of S&T Policy
Committee on Operational Environmental Satellites
Cooperative R&D on Space Projects (DARPA)
Countermine Coordination Meeting (CMCM)
DIA and Services Intelligence Data Handling
DMA and Services Mapping and Charting
DNA Test Plan Review Panel
DoD Arctic Symposium and Workshop on Arctic and Arctic-Related Environmental
Sciences
DoD Atmospheric Transmission Program
DoD Computer-Aided Logistics Support Steering Group
DoD Environmental Quality Topical Review
DoD Environmental Technical Exchange Conference Working Group Steering Committee
(DoD ETEC)
DoD Explosive Safety Board
DoD Human Factor Technology Advisory Group
DoD Human Factors Engineering Technical Advisory Group
DoD InfraRed Information and Analysis Center (and other ITACs)
DoD Manufacturing Technology Advisory Group
DoD Metal-Matrix Composite Steering Committee
DoD Missile Aerodynamics/Structures Technology Coordinating Committee
DoD Photovoltaic Enhancement Program (E&C Mission) (PREP)

DoD Tri-Service and Industry Coating Removal Conference
 DoD/NASA Integrated High Performance Turbine Engine Technologies Initiative
 Environmental Sciences Tri-Service Briefings
 Explosive Countermine Technology Colloquium
 Federal Coordinating Council for Science, Engineering and Technology (with subcommittees)
 Federal Coordinator for Meteorological Services and Supporting Research
 Federal Laboratory Consortium for Technology Transfer (FLC)
 Fixed Installation Smoke System Evaluation (FISSE)
 Human Factors Engineering Technical Advisory Group
 Image Exploration Programs Coordinating Group
 Insensitive Munitions Working Group
 Installation and Restoration Technical Coordinating Committee (IRTCC)
 Inter-Service Camouflage, Concealment, and Deception Obscuration Group (Army, Navy, Air Force, and Marines) (Inter-Service CCDO Study)
 Interagency Advanced Power Group (IAPG) (with subcommittees)
 Interagency Committee for Extramural Mathematics
 Interagency Group on Remote Sensing
 Interagency Roofing Research Coordinating Group
 Interagency Working Group on Neuroscience
 Interservice Antenna Group
 JDL, Technical Panel for Command and Control
 JDL, Tri-Service Laser Radar Panel
 JLC Joint Policy Group for Logistics R&D
 Joint Army, Navy, NASA, Air Force Interagency Propulsion Committee (JANNAF)
 Joint Army, Navy, NASA and Air Force Subcommittee on Environment and Safety
 Joint Chemical Effects Data Research Guide (JCEDDAR)
 Joint Committee on Tactical Shelters (JOCOTAS)
 Joint Conventional Communication Program
 Joint Directors of Laboratories (JDL) Technology Panel on Advanced Materials (TPAM)
 Joint Development Objective Guide (JDOG)
 Joint Environmental Satellite Coordinating Group (JESCG)
 Joint Integrated Avionics Working Group
 Joint Logistics Commanders (JLC) Signal Processing Technology Panel
 Joint Logistics Commanders (JLC) Systems Software Safety Panel
 Joint Logistics Commanding Generals Munitions Militarization and Disposal Subgroup
 Joint Logistics Over the Shore Technology Transfer Workshop
 Joint Ordnance Commander's Group
 Joint Service Coordination of Chemical Warfare and Chemical-Biological Defense Requirements, Research, Development, and Acquisition
 Joint Service Seeker Working Group
 Joint Services Civil Engineering Research and Development Coordinating Group (JSCERDCG)
 Joint Services Electronics Program
 Joint Technical Coordinating Group for Aircraft Survivability and Electronic Warfare
 Joint Technical Coordinating Group for Munitions Effectiveness
 Joint Technical Coordination Group for Munitions Effectiveness Smart Munitions Working Group (ad hoc) (JTCG-ME/SMWG)
 Joint Technical Coordinating Group for Munitions Effectiveness Smoke and Aerosol Working Group (JTCG-ME/SAWG)

Joint Technical Coordinating Group for Munitions Effectiveness Surface Targets
 Vulnerability Panel
 Joint Technical Group on Thermal Imaging Sensors
 Joint Technology Coordinating Group on Space Based Radar
 Joint Technology Coordinating Group for Simulation and Training Devices
 Joint Technology Demonstrator Engine Program
 JSCERDCG Subcommittee on Base Survivability (JSCERDCG-Base Survivability)
 JSCERDCG Subcommittee on Energy (JSCERDCG-Energy)
 JSCERDCG Subcommittee on Expert Systems (JSCERDCG-Expert Systems)
 JSCERDCG Subcommittee on Facility Diagnostics (JSCERDCG-Facility Diagnostics)
 JSCERDCG Subcommittee on Pavements (JSCERDCG-Pavements)
 JSCERDCG Subcommittee on Physical Security (JSCERDCG-Physical Security)
 Military Man-In-Space Program (Inter-Service)(MMIS)
 Mobility Fuels Technical Action Coordinating Committee
 Mobility Fuels Technical Action Coordinating Committee
 NASA/AFSC Space Technology Interdependency Group
 NASA/Air Force Space Technology Interdependency Working Group
 NASP Joint Program Office
 NASP Steering Group
 National Materials Advisory Board
 NATO AC243 Panel Group (1) Camouflage Radar Experiment (Tri-Service US Participation)
 NATO AC243 Working Group (D) (Tri-Service US Participation)
 NATO Committee on Protective Construction
 NATO International Aviation Fuel Standardization
 Non-Strategic Nuclear Forces Security Survivability Safety (Program Advisory Group) (NSNFS3 PAG)
 Non-Strategic Nuclear Forces Security, Survivability Safety (Program Officers Group) (NSNFS3 POG)
 NSA and Services in Signal Intelligence and Computer Security
 Nuclear Effects Survivability and Weapons Hardening Committee
 Office of the Under Secretary of Defense for Research and Advanced Technology (OUSD/R&AT), S&T Reviews, e.g., Tri-Service Environmental Sciences Review
 OSD (Force Management and Personnel) Working Groups
 OSTP Committee on Materials
 Pavement and Railroad Engineers Meeting
 Protective Construction Seminars
 Radiation Hardened Electronics Technology Coordinating Group
 Radiation Hardened Electronics Technology Coordinating Group
 Research Study Group, NATO AC-243, Panel IV
 Research Study Group 8 (Tri-Service US Participation) (NATO AC-243, Panel III, RSG.8)
 Research Study Group 11 (NATO AC-243, Panel III, RSG.11)
 Research Study Group 13, NATO AC-243
 SEI JAC-Executive Group
 SEI Joint Advisory Committee (JAC)
 SEI Technical Review Committee
 Shock and Vibration Symposium
 SNOW Symposium

STIG AF/NASA Technology Interdependency Group
Strategic Defense Initiative Organization/Innovative Science and Technology (SDIO/IST)
Tactical Missile Propellants
Tactical Weapon Guidance and Control Information Analysis Center (GACIAC)
The Four Power Air Senior National Representatives
The Technical Cooperation Program (TTCP) (with working groups)
Tri-Service Aeromedical Research Panel
Tri-Service Airborne Displays Working Group
Tri-Service Automatic Target Recognition Working Group
Tri-Service Combat Identification System Program
Tri-Service Commander's Conference
Tri-Service Committee on Composite Supportability
Tri-Service Committee on Kapton Wiring
Tri-Service Committee on Non-Destructive Inspection
Tri-Service Coordinating Committee for MIL-STD-810
Tri-Service Electromagnetic Radiation Panel
Tri-Service Fiber Optic Coordinating Group (with working groups)
Tri-Service GO Steering Committee Armed Services Vocational Aptitude Battery
Tri-Service Laser Bioeffects Working Group
Tri-Service Laser Hardened Materials and Structure Group
Tri-Service Manufacturing Technology Working Group
Tri-Service Paint Committee
Tri-Service Requirements Working Group (TSRWG)
Tri-Service Space Experiment
Tri-Service Working Group/IFF Countermeasures
Tri-Service Working Group/Physical Security
Tri-Service/Industry Infrared Working Group
Working Group on Satellite Meteorology
Working Party for Explosives

Appendix F

DoD LABORATORIES BY MAJOR FUNCTION

DoD LABORATORIES BY MAJOR FUNCTION*

<u>LABORATORY</u>	<u>SERVICE</u>	<u>TOTAL RDTE (K\$)</u>	<u>S&T PRGM (K\$)</u>
<u>RESEARCH</u>			
Naval Research Laboratory	N	338,336	123,153
Vulnerability Assessment Laboratory	A	0	0
<u>AERONAUTICS/PROPULSION</u>			
Air Development Center	N	194,726	49,167
Missile RDE Center	A	174,685	93,772
Flight Dynamics Laboratory	AF	130,113	8,081
Aero Propulsion Laboratory	AF	123,347	63,920
Aviation Research & Technology Laboratory	A	99,544	29,566
Astronautics Laboratory	AF	44,724	38,930
Frank J. Seiler Research Laboratory	AF	2,022	2,022
Navy Space Systems Activity (New)	N	0	0
<u>BIOMEDICAL</u>			
Walter Reed Army Institute of Research	A	72,700	49,537
Medical Research Institute Chemical Defense	A	39,386	29,881
Medical Research Institute of Infectious Diseases	A	33,853	19,498
Armstrong Aeromedical Research Laboratory	AF	32,138	25,177
Medical Bioengineering R&D Laboratory	A	26,614	11,167
School of Aerospace Medicine	AF	24,142	21,722
Medical Research Institute	N	17,474	9,064
Letterman Army Institute of Research	A	12,543	10,898
Aeromedical Research Laboratory	A	6,527	6,483
Institute of Dental Research	A	4,854	4,681
Medical Research Unit 3	N	4,289	1,659
Biodynamics Laboratory	N	3,847	537
Institute of Surgical Research	A	3,549	3,509
Aerospace Medical Research Laboratory	N	3,461	1,516
Health Research Center	N	3,177	870

* Funding is based on 1984 RDT&E Report. Laboratory list is based on OUSD(A) Task Force Documents. Reference: *Department of Defense In-House RDT&E Activities*, 30 October 1985.

<u>LABORATORY</u>	<u>SERVICE</u>	<u>TOTAL RDTE (K\$)</u>	<u>S&T PRGM (K\$)</u>
<u>BIOMEDICAL (Continued)</u>			
Biosciences Laboratory	N	2,830	2,830
Medical Research Unit No. 2	N	2,739	1,253
Dental Research Institute	N	1,065	229
<u>CIVIL ENGINEERING</u>			
Ft. Belvoir R&D Center	A	123,801	11,502
Engineer Topographic Laboratories	A	50,909	15,530
Engineer Waterways Experiment Station	A	37,407	11,600
Construction Engineering Research Laboratory	A	25,123	20,037
Engineering and Services Center	AF	19,271	4,398
Cold regions R&E Laboratory	A	12,379	10,673
<u>CHEMICAL/BIO</u>			
Chemical R&D Center	A	126,116	54,762
<u>ENVIRONMENTAL</u>			
Geophysics Laboratory	AF	79,227	63,876
Atmospheric Sciences Laboratory	A	29,725	10,251
Research Institute of Environmental Medicine	A	6,024	5,429
Environmental Prediction Research Facility	N	5,292	3,538
<u>ELECTRONICS</u>			
Avionics Laboratory	AF	335,682	85,381
Rome Air Development Center	AF	259,466	111,087
Electronic Warfare Laboratory	A	126,652	5,609
Communications and ADP Directorate	A	124,260	21,852
Center for Night Vision	A	98,461	28,275
Electronics Technology and Devices Lab	A	76,536	24,054
Signals Warfare Directorate	A	49,621	4,451
Electronic WF/Recon and Target Acq Dir	A	23,352	2,009
Avionics R&D Activity	A	20,679	8,819
<u>HUMAN FACTORS</u>			
Human Resources Laboratory	AF	54,501	31,066
Research Inst for Behavioral and Social Sci	A	49,137	13,554
Personnel Research and Development Center	N	18,453	5,680
Human Engineering Laboratory	A	17,591	14,407
<u>MATERIALS</u>			
Materials Laboratory	AF	132,108	71,589
Materials Technology Laboratory	A	36,362	17,918

<u>LABORATORY</u>	<u>SERVICE</u>	<u>TOTAL RDTE (K\$)</u>	<u>S&T PRGM (K\$)</u>
<u>PERSONAL EQUIPMENT</u>			
Natick R&D Center	A	51,712	18,725
Clothing and Textile Research Facility	N	3,116	1,599
<u>SHIPS/SYSTEMS</u>			
Ocean Systems Center	N	272,700	66,257
David W. Taylor Naval Ship R&D Center	N	187,749	55,886
Underwater Systems Center	N	175,799	25,833
<u>TANK/AUTOMOTIVE</u>			
Tank/Auto Command R&D Center	A	216,925	28,073
<u>WEAPONS</u>			
Surface Weapons Center	N	331,206	87,669
Weapons Center	N	280,809	39,465
Weapons Laboratory	AF	255,999	48,089
Fire Support Armament Center	A	107,790	37,178
Harry Diamond Laboratories	A	80,496	29,876
Armament Laboratory	AF	70,201	43,088
Ballistic Research Laboratory	A	61,026	31,594
Coastal Systems Center	N	59,351	10,586
Close Combat Armament Center	A	44,850	23,075

Section III

WORKING GROUP C, ADVOCACY

REPORT OF WORKING GROUP C ADVOCACY OF THE S&T PROGRAM

A. THE ADVOCACY WORKING GROUP

The Advocacy Working Group (Working Group C) of the Task Force for Improved Coordination of Science and Technology Programs is one of three working groups formed at the direction of the Task Force's Core Group. Its charter from the Core Group instructed the Working Group to develop recommendations "to improve the external and internal [to DoD] understandings of the importance of an effective S&T program as a necessary investment in future war fighting capabilities."

B. THE SCIENCE AND TECHNOLOGY PROGRAM

1. The Contribution of the Science and Technology Program to DoD

One of the cornerstones of U.S. military strategy is to maintain and advance the qualitative superiority of its military capabilities so as to offset the numerical advantages and growing technological sophistication enjoyed by the Soviet Union:

As part of the United States' deterrent strategy, it relies heavily on technological rather than numerical superiority. Its strong technological position has always balanced sheer Soviet numerical advantages and thereby added to deterrence...[However, the] Soviets are clearly committed to dedicating the R&D resources necessary to improve their weaponry. Indeed, the technological advantages in military capabilities now enjoyed by the West have been threatened, if not eroded...If [the Soviets] seize the initiative and continue to reduce the West's technological advantages, the United States and its allies will be forced to expend even greater resources, or accept greater risks to collective security...It is imperative, therefore, that the United States invest wisely to maintain its technological advantages.¹

¹ U.S. Department of Defense, *Soviet Military Power: An Assessment of the Threat*, 1988, p. 140.

The technological gap between the U.S. and the Soviet Union is narrowing. If more is not done to reverse this decline, the U.S. will have to reconsider its reliance on a strategy of technological superiority.

Every military system currently in the inventory is the legacy of a successful science and technology program investment made 10-20 years earlier. Examples of the positive impact of science and technology include:

- U.S. fighter aircraft air superiority
- precision guided munitions (e.g., Maverick, TOW)
- air-to-air missiles (Sidewinder, Sparrow, AMRAAM)
- SLBM, silent submarine, and ASW capabilities
- look-down-shoot-down radars
- stealth capability
- large bypass turbine engines for transport service.

Current science and technology efforts will result in:

- highly autonomous robotic land vehicles
- improved surveillance and communication links through the use of ultra-low-loss optical fibers
- dramatic improvements in the thrust-to-weight ratios and fuel consumption in fighter and attack aircraft turbine engines
- hypersonic flight
- advanced space capabilities
- medical countermeasures to chemical and biological weapons
- blood substitutes and fluid volume expanders that are available far forward on the battlefield
- a broad spectrum of vaccines against military disease hazards.

A formal listing of some of the critical technologies of the 1950s and 1960s that provided for many of the capabilities of today's Navy is provided in Appendix B. A similar listing for technologies of the 1970's current or future applications is also included in Appendix B.

In addition to providing the U.S. with important technological advances and breakthroughs, investments in science and technology also help us to avoid "technological

surprises" brought on by the Soviet's own extensive research efforts. More generally, defense investments in science and technology ensure that the military will have access to the specific technologies it needs to help it fulfill its numerous mission requirements. Because of these specialized requirements, DoD is unable to rely fully on commercial technological developments (although many of these, particularly in microelectronics and computers, are critical to the military).

2. What Is Science and Technology?

DoD's science and technology program includes:

- Research (budget category 6.1);
- Exploratory Development (6.2); and
- Advanced Technology Development (6.3A).

The science and technology program does not include efforts which are unique to a particular system, specifically:

- Advanced Development (6.3B)
- Full Scale Engineering Development (6.4).

The science and technology program can be characterized as consisting of the development of experts and knowledge, as opposed to hardware development efforts. (The latter constitute the major portions of the R&D budget.) The S&T program provides the technological advances required to develop advanced, superior weaponry and other military systems and capabilities. Science and technology research efforts are conducted through in-house laboratories and research centers, through contracts with academia and industry, and jointly with other federal agencies. Examples of activities undertaken in the 6.1 program include:

- High temperature superconductivity
- Neural network computers
- Ultra-structured materials.

Examples of 6.2 programs include:

- Advanced navigation technologies
- Insensitive high explosives
- Advanced compressor and turbine component technology
- Optical processing.

The 6.3A program includes important developments in:

- Advanced torpedo guidance systems
- Advanced intelligence fusion techniques
- Advanced technology demonstrator engines.

3. The Decline in Science and Technology Resources

The members of the Advocacy Working Group view with particular alarm the steady erosion of resources devoted to science and technology by the Department of Defense. This has been a major factor in the decreasing U.S. technological superiority. If the decline in resources devoted to science and technology is not reversed, the impact on the relative technological capabilities of U.S. weaponry and forces may be compromised so much that we will need to rethink our basic strategy of using qualitatively superior weapons to offset numerical disadvantages.

Although the importance of, and resource problems faced by, the S&T program have been chronicled in numerous reports, the decline in resources devoted to the Science and Technology portion of the R&D budget continues to be news to many policy makers. (One problem is that the funding of SDI through the 6.3A budget has obscured the decline in resources devoted to the remainder of the science and technology program.) Spending on basic research (budget area 6.1), exploratory development (6.2), and advanced development (6.3A)--exclusive of expenditures on the Strategic Defense Initiative--declined from 2.3 percent of Total Obligational Authority (TOA) in fiscal year 1974 to 2.0 percent of TOA in fiscal year 1988 (see column 12, Table III-1). Of particular concern is the steady downward trend in investment in 6.1 and 6.2 (see columns 9 and 10 of Table III-1). These areas of research and exploratory development are a primary source of new ways to utilize technology for military purposes. These basic trends have been partially obscured by the fact that DoD's RDT&E budget has increased dramatically over that same period.

There are numerous reasons for this decline in resources. To begin with, senior Service and OSD officials, as well as members of Congress and their staffs, are in many cases insufficiently aware of the science and technology program's accomplishments, and the full extent of its significance as an investment in our future national security. Just as in the private sector, science and technology must come to be viewed as a cost of doing business, not a luxury that can only be afforded in good times. DoD's commitment to this

Table III-1. TOA, Science and Technology Program, 1968-1988
(Billions of 1988 Dollars)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
YEAR	6.1	6.2	6.3A w/o SDI	TOTAL S&T w/o SDI	6.3A SDI	6.3A TOTAL	TOTAL S&T	TOA (Billions)
70	1,057	3,281		4,338			4,338	242
71	991	3,040		4,031			4,031	218
72	976	3,308		4,230			4,284	212
73	867	3,177		4,043			4,043	202
74	805	2,945	787	4,537		787	4,537	195
75	738	2,671	876	4,285		876	4,285	188
76	727	2,619	933	4,279		933	4,279	195
77	775	2,711	1,021	4,507		1,021	4,507	205
78	803	2,702	972	4,477		972	4,477	202
79	849	2,745	1,009	4,602		1,009	4,603	202
80	908	2,813	940	4,662		940	4,662	206
81	917	2,968	834	4,719		834	4,719	232
82	970	3,107	1,026	5,102		1,026	5,102	259
83	1,050	3,282	1,102	5,434		1,102	5,434	280
84	1,083	2,853	1,755	5,691	63	1,817	5,753	293
85	1,055	2,820	1,631	5,506	1,726	3,356	7,231	315
86	1,140	2,724	1,679	5,543	3,182	4,861	8,725	302
87	1,044	2,742	1,980	5,766	4,360	6,340	10,125	298
88	1,038	2,830	2,207	6,074	5,877	8,084	11,951	303

	(9)	(10)	(11)	(12)	(13)	(14)	(15)
YEAR	6.1 as % TOA	6.2 as % TOA	6.3A w/o SDI as % TOA	TOTAL S&T w/o SDI as % TOA	6.3A SDI as % TOA	6.3A w/SDI as % TOA	TOTAL S&T as % TOA
70	0.44	1.36		1.79			1.79
71	0.45	1.40		1.85			1.85
72	0.46	1.56		2.02			2.02
73	0.43	1.57		2.00			2.00
74	0.41	1.51	0.40	2.33		0.40	2.33
75	0.39	1.42	0.47	2.28		0.47	2.28
76	0.37	1.34	0.48	2.19		0.48	2.19
77	0.38	1.32	0.50	2.20		0.50	2.20
78	0.40	1.34	0.48	2.22		0.48	2.22
79	0.42	1.36	0.50	2.28		0.50	2.28
80	0.44	1.37	0.46	2.26		0.46	2.26
81	0.40	1.28	0.36	2.03		0.36	2.03
82	0.37	1.20	0.40	1.97		0.40	1.97
83	0.38	1.17	0.39	1.94		0.39	1.94
84	0.37	0.97	0.60	1.94	0.02	0.62	1.96
85	0.34	0.90	0.52	1.75	0.55	1.07	2.30
86	0.38	0.90	0.56	1.84	1.05	1.61	2.89
87	0.35	0.92	0.66	1.94	1.46	2.13	3.40
88	0.34	0.93	0.73	2.01	2.94	2.67	3.94

"cost of doing business" is essential if the United States is to continue relying on a strategy of technological superiority.

The problems associated with adequate funding of the S&T program were given special attention by a recent Office of Technology Assessment report:

Funding for technology base programs is particularly vulnerable during times of tight budgets. The rapid spend-out rates of technology base programs mean that cuts in R&D go farther toward reducing deficits than similar size cuts in procurement programs. And the lack of obvious, tangible outputs from R&D projects makes the value of individual programs difficult to define. Technology base programs are particularly vulnerable to "raiding" to support programs in procurement or the later stages of development.²

In recent years the SDI program has been supported from 6.3A efforts. Thus, although some SDI endeavors are important to non-SDI S&T efforts, when SDI expenditures are included in other DoD science and technology activities, they provide a misleading impression of budgetary growth in the broader base of science and technology efforts (see Table III-1 above, columns 7 and 14).

4. The Role of DoD's Science and Technology Program

The role of the science and technology program is to ensure that all of DoD's military capability needs are being met. DoD seeks to fulfill this role by maximizing the return on its own S&T investments, and without the undue duplication of efforts being supported elsewhere, including other government laboratories, industry, or universities. There are a number of important reasons for DoD to make its own investments in science and technology. They fall into four broad categories:

a. Essential, High-Risk Projects

Some technologies are recognized as having a high potential for military applications, but are very high-risk projects nonetheless. In many cases it is necessary for DoD to take the lead in promoting such S&T efforts because of the absence of incentives for other institutions to do so.

b. Unique Military Requirements

Some areas of science and technology research are required for unique military applications. Examples include not only such areas as chemical warfare defense, anti-

² U.S. Congress, Office of Technology Assessment, *The Defense Technology Base: Introduction and Overview*, OTA-ISC-374, Washington D.C., March 1988.

submarine warfare technology, directed energy weapons, and advanced fuzing techniques, but the unique supportability requirements of many military systems, the unique requests made of military civil engineering, and medical research for vaccines that would be in little demand until U.S. forces were required to deploy to regions with rare diseases. If DoD does not take the lead in developing comprehensive research programs in these and other areas, they will be neglected no matter how important they may be.

c. Need to Understand, Push, and Exploit Emerging Technologies

DoD's objective is to field technologically superior military capabilities. This often provides it with a different set of incentives than those faced by private industry. In particular, it may prove very valuable to the military to invest in a promising technology at a time when private industry believes that same technology is too far away from a commercial payoff to warrant a significant level of investment. Because of the time urgency of its requirements, it often benefits DoD to invest resources to push the development of new and potentially important technologies more rapidly. Finally, investments in S&T have the added benefit of guaranteeing that a highly trained cadre of experts is available to ensure that DoD acquires cost effective military systems.

d. Need to Demonstrate the Military Applications of Specific Technologies

There are many cases in which a technology or technological advancement appears to have important military utility, but that military utility has yet to be demonstrated. How useful will a new technology be, in what ways will it be useful, and how can its military utility be improved? Determining the true value of new technologies, and directing research and development efforts in the most efficient directions, are thus important roles played by the DoD science and technology program.

C. FINDINGS AND RECOMMENDATIONS

1. Treat S&T as a Corporate Investment

a. Finding

The narrowing of the technological gap between the United States and the Soviet Union has potentially far-reaching implications for the US military posture. Reversing this trend must be seen as one of the main priorities of the Department of Defense in the years ahead. DoD's science and technology community can continue to provide the advances

required for technologically superior war-fighting capabilities only if it is provided sufficient support from the higher management levels in DoD and in Congress. The long term value of investments in Science and Technology R&D must not be eroded by budget decisions in favor of more immediate short-term requirements. The relatively small amount of resources devoted to Science and Technology programs--less than 2 percent of the entire DoD budget--should be treated as a necessary cost of retaining superior war-fighting capabilities over the long term. S&T program costs must be viewed as an essential corporate investment.

b. Recommendation

- DoD should arrest the erosion of the current S&T program and establish and enforce rational goals for future growth. These goals should be established as a percentage of TOA, and not be subjected to trade-offs with other parts of the budget.

Implementation:

- OSD will establish an end-of-FYDP goal, based on a coordinated DoD Investment Strategy, require annual growth to achieve this goal, and protect the S&T programs against disproportionate cuts during budget exercises. This can only be accomplished by the issuance of a directive signed by the Secretary of Defense.
- Pending issuance of this directive, the SecDef should ensure that the FY-90 S&T budget (exclusive of SDI) experiences positive real growth.

2. Improve High Level Management Support for S&T

a. Findings

Part of the advocacy problem that the S&T program faces is directly attributable to its small relative size, which, from a financial viewpoint, tends to make it a second order consideration. To offset this tendency, the fact that the S&T program is the cornerstone of future US technological superiority in its war-fighting capabilities needs to be constantly communicated to the senior decision makers in DoD. They in turn must become explicit and pro-active advocates of S&T program investments.

In order to support the senior decision makers' advocacy of the S&T program, they must be kept better informed of its objectives, accomplishments, and contributions. No one can be expected to support a program on faith alone. An additional benefit of

providing such improved communication will be an increased emphasis on management and productivity improvements. The increased visibility will make S&T program managers more accountable for meeting the program objectives that have been set.

b. Recommendations

(1) Improve High Level Advocacy to Deliver Message

- The Secretary of Defense and other senior DoD decision makers should be explicit and pro-active in advocating the S&T program.

Implementation:

- USD(A) should personally provide highly visible advocacy for the S&T program.
- Support of the S&T program should be articulated in all OSD, Service, and Agency posture statements.
- CINC and other user support must be cultivated by Service S&T program sponsors.
- USD(A) should direct that an annual review of the S&T program be given to the Defense Acquisition Board (DAB) by the chairman of the S&T Committee of the DAB.

(2) Improve Communication of Science and Technology Program Successes

- Science and technology program accomplishments and contributions should regularly be brought to the attention of senior OSD and Service decision makers, the CINCs, and Congress.

Implementation:

- Annual update by the chairman of the DAB S&T Committee to the DAB of S&T achievements relative to the S&T Investment Strategy, including the transitioning of technology to system application.
- Unclassified DoD annual science and technology program report.
- Publicize significant S&T results.
- Encourage lab visits by Congressmen, DSB members, senior OSD and Service decision makers, etc.

(3) Improve Image of S&T Program Management

- Improvements in S&T Program management and other actions taken to increase productivity should be regularly brought to the attention of senior DoD and Congressional decision makers.

Implementation:

- SecDef should be periodically advised on S&T management issues.
- Annual update to the DAB of S&T management improvements and ongoing actions by R&AT with Service support.
- Publicize significant S&T management achievements, and include in an unclassified DoD annual S&T program report.

Appendix A

WORKING GROUP C -- LIST OF MEMBERS

WORKING GROUP C MEMBERS

1. Mr. Brett Able
Office of the Under Secretary of Defense for
Research and Advanced Technology (OUSD/R&AT)
The Pentagon, Room 3E114
Washington, DC 20301-3080
Telephone: (202) 697-9001
Autovon: 227-9001
2. Col. Joseph Denniston
Office of the Assistant Surgeon General
for Research and Development
Department of the Army
The Pentagon, Room 3E474
Washington, DC 20310-2300
Telephone: (202) 695-1449
Autovon: 295-1449
3. Dr. Gary L. Denman
Deputy Director, Air Force Wright
Aeronautical Laboratory
Wright Patterson Air Force Base, OH 45433
Telephone: (513) 255-3724
Autovon: 785-3724
4. Dr. Hamed El-Bisi
Deputy Director, Army R&T (Res. & Lab. Mgt.)
Code: SARD/TR
The Pentagon, Room 3E474
Washington, DC 20310-0103
Telephone: (202) 695-1447
Autovon: 225-1447
5. Mr. Michael Flynn
Technical Advisor
Directorate for Science and Technology
SAF/AQT
The Pentagon, Room 4D289
Washington, DC 20330-1000
Telephone: (202) 695-9826
Autovon: 225-9826
6. Mr. Bruce Fonoroff
Director, Technology Planning and
Management
LABCOM
2800 Powder Mill Road
Adelphi, MD 20738-1145
Telephone: (301) 394-3300
7. Gen. Robert T. Marsh, USAF (Ret.)
6327 Manchester Way
Alexandria, VA 22304
Telephone: (703) 370-6319

8. Col. James M. McCormack
Assistant Deputy Chief of Staff
Technology and Requirements Planning
HQ AFSC/XT
Andrews AFB, DC 20334-5000
Telephone: (301) 981-5416
Autovon: 858-5416
9. Mr. Robert Moore
Deputy Director
Office of the Chief of Naval Research
Office of Naval Technology (ONT - 20D)
800 North Quincy
Arlington, VA 22217-5000
Telephone: (703) 696-5117
Autovon: 226 - 5117
10. Mr. Raymond Siewert
Director, Engineering Technology
OUSD/R&AT
The Pentagon, Room 3D1089
Washington DC 20301-3080
Telephone: (202) 697-7922
11. Mr. Marshall John Tino
Associate Technical Director
Naval Surface Warfare Center, Code D2
White Oak
10901 New Hampshire Ave
Silver Spring MD 20903-5000
Telephone: (301) 394-1251/(703) 663-8201
Autovon: 290-1251/249-8201
12. Dr. William M. Tolles
Associate Director of Research
for Strategic Planning
Naval Research Lab, Code 1003
4555 Overlook Ave
Washington DC 20375-5000
Telephone: (202) 767-3584
Autovon: 297-3584

Appendix B

IMPORTANT TECHNOLOGIES AND THEIR APPLICATIONS

Table B-1. Technologies of the 1950s and 60s Have Provided Revolutionary Capabilities for Today's Navy

TECHNOLOGY	NAVAL APPLICATION	CAMPAIGNS FEASIBLE WHICH PREVIOUSLY WERE NOT FEASIBLE	REVOLUTIONARY NATURE OF IMPACT
Naval nuclear propulsion	• SSN	• Submarine as offensive Naval weapon system in forward areas	• Basis for today's submarine to become premium weapons system for offensive sea control and strike
	• SSBN	• New basing options for ICBMs	• Enable highly survivable element of strategic force structure
Radar missile guidance	• Anti-ship missile	• Stand-off attack of ships	• Place capital ships at risk worldwide
	• Air-to-air missile	• Stand-off attack of aircraft	• Engage threat aircraft without placing own platform at risk
Passive acoustic arrays	• Fixed undersea surveillance system	• Reliable choke point and basin surveillance	• Global surveillance of threat submarines
Ultra-high resolution photography	• Satellite reconnaissance	• Reconnaissance of enemy homeland from sanctuaried environment	• Highly effective means for judging threat military capabilities; not reliant on HUMINT
Night vision devices/FLIRs	• Fighter/attack aircraft fire control	• Enabled high intensity operations at night	• Doubling of opportunities for target engagement; exploit cover of darkness
Ultra-high performance inertial sensors	• Intercontinental range missile	• Highly lethal strike of strategic targets at global ranges	• Placed all enemy targets at risk without need for penetration by manned platform

Table B-2. Technologies of the 1970s Have Provided (or Soon Will) Revolutionary Capabilities for Today's Navy

TECHNOLOGY	NAVAL APPLICATION	CAMPAIGNS FEASIBLE WHICH PREVIOUSLY WERE NOT FEASIBLE	REVOLUTIONARY NATURE OF IMPACT
Stealth	<ul style="list-style-type: none"> Tactical fighters and attack aircraft 	<ul style="list-style-type: none"> Penetrate highly lethal air defense (surface-to-air, air-to-air) 	<ul style="list-style-type: none"> Counter tremendous enemy investment in air defense (surface-to-air, air-to-air)
Space-qualified, wide-band telecommunications	<ul style="list-style-type: none"> Near real time transmission of reconnaissance data to tactical users 	<ul style="list-style-type: none"> Provides surveillance means for stand-off engagements 	<ul style="list-style-type: none"> Global surveillance of major threat force elements
'R missile guidance	<ul style="list-style-type: none"> Surface-to-air and air-to-air missiles 	<ul style="list-style-type: none"> Very effective anti-helo capability 	<ul style="list-style-type: none"> Highly effective, affordable weapon usable by GIs/Third World (e.g., Afghanistan)
Terrain mapping missile guidance	<ul style="list-style-type: none"> Strategic cruise missile 	<ul style="list-style-type: none"> Enable strategic strike capability at very long stand-off ranges 	<ul style="list-style-type: none"> Global strike of land targets with cruise missile
Microelectronics/microcomputers	<ul style="list-style-type: none"> Lightweight torpedo 	<ul style="list-style-type: none"> Enable air-launched ASW torpedo 	<ul style="list-style-type: none"> Untethered/autonomous torpedo guidance and control
Autonomous ARM guidance	<ul style="list-style-type: none"> Defense suppression 	<ul style="list-style-type: none"> Negate SAM radar fire control Allow interdiction of heavily defended targets 	<ul style="list-style-type: none"> Extremely high lethality against known emitters/radars
Remotely piloted vehicles	<ul style="list-style-type: none"> EW harassment and decoying 	<ul style="list-style-type: none"> Enable penetration of intense SAM environment 	<ul style="list-style-type: none"> Very high success at decoying in support of Israeli operations
Very low cost microwave receivers	<ul style="list-style-type: none"> Global positioning system 	<ul style="list-style-type: none"> Enable highly effective strike weapon capability at very low cost 	<ul style="list-style-type: none"> Greatly decrease costs of PGMs, putting more capability in the hands of the troops
Higher power, compact TWTs	<ul style="list-style-type: none"> Aircraft ECM system 	<ul style="list-style-type: none"> Provide capability to conduct conventional operations even in highly defended environments 	<ul style="list-style-type: none"> Waveform and frequency capability to counter all known radar threats

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Defense Science Board, OUSD(A)
Room 3D1020, Pentagon
Washington, DC 20301-3140

ATTN: Eugene G. Fubini

1

Dr. Raymond S. Colladay
Director, Defense Advanced Research Projects Agency
1400 Wilson Boulevard
Arlington, VA 22209-2308

2

Mr. David Applier
Staff Specialist
ODUSD(R&AT/RLM)
Rm. 3E114, The Pentagon
Washington, DC 20350

1

Dr. Paris Genalis
Staff Specialist, R&AT
IR&D, Emerging Technology
Rm. 3D367, The Pentagon
Washington, DC 20301-3080

1

Dr. John MacCallum, R&AT
Director, Electronic Systems Technology
Rm. 3D359, The Pentagon
Washington, DC 20301-3080

1

Dr. Michael Neeb, R&AT
Staff Specialist, Laboratory Management
Rm. 3D367, The Pentagon
Washington, DC 20301-3080

1

Mr. William Noll, R&AT
Staff Specialist, Laboratory Management
Rm. 3D367, Pentagon
Washington, DC 20301-3080

1

Mr. Ben Wilcox
Assistant Director, DARPA
1400 Wilson Boulevard
Arlington, VA 22209-2308

1

Office of the Secretary of Defense
OUSDRE (DoD-IDA Management Office)
1801 N. Beauregard Street
Alexandria, VA 22311

1

Defense Technical Information Center
Cameron Station
Alexandria, VA 22304-6145

2

Miscellaneous, U.S. Government

Mr. Michael E. Davey 2
Analyst in Science and Technology
Science Policy Research Division
Congressional Research Service
Library of Congress
Washington, DC 20540

Department of the Army

BG Richard Beltson 1
Deputy for Technology and Assessment
HQDA, SARD-ZT
Rm. 3E374, The Pentagon
Washington, DC 20310-0103

Mr. Robert O. Benn 9
Assistant Director, Military Programs
Office of Corps of Engineers
Code: CERD-M
20 Massachusetts Avenue
Washington, DC 20314-1000

Dr. James Bynum 1
Chief, Plans, Programs, and Operations
US Army Research Institute for the Behavioral
and Social Sciences
5001 Eisenhower Avenue
Alexandria, VA 22333-5600

Col. Harry G. Dangerfield 1
Executive Assistant to the PEO for
Health Care Systems
Bldg. 521, Room 26
Fort Detrick
Frederick, MD 21701-5012

Col. Joseph Denniston 1
Office of the Assistant Surgeon General
for Research and Development
Department of the Army
Rm. 3E474, The Pentagon
Washington, DC 20310-2300

Dr. Hamed El-Bisi 1
Deputy Director, Army R&T (Res. & Lab. Mgt.)
Code: SARD/TR
Rm. 3E474, The Pentagon
Washington, DC 20310-0103

Mr. Bruce Fonoroff Director, Technology Planning and Mgt. LABCOM 2800 Powder Mill Road Adelphi, MD 20738-1145	1
Dr. John Harrison Chief, Environmental Laboratory US Army Engineer Waterways Experiment Station P.O. Box 631 Vicksburg, MS 39180	1
Mr. Phillip Howe Antiarmor Munitions Technology Office Attn: AMCLD, Bldg. 328 Aberdeen Proving Group, MD 21005-5006	1
Dr. Michael Kaplan Director, Basic Research US Army Research Institute 5001 Eisenhower Avenue Alexandria, VA 22333-5000	2
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Mr. James Predham DCS for Corporate Technology, LABCOM ATTN: AMSLC-CT, Bldg. 205, Rm. 2E020 2800 Powder Mill Road Adelphi, MD 20738-1145	1
Dr. Lawrence J. Puckett Associate Director US Army Ballistic Research Laboratory ATTN: SLCBR-DA, Bldg. 328 Aberdeen Proving Ground, MD 21005-5006	1
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Dr. Richard Shaffer 8
Technical Director
Construction Engineering
Research Laboratory
Champaign, IL 61820

Mr. George Taylor 3
Associate for Technical & Engineering
AED ARDEC
Attn: SMCAR-AE George Taylor
Picatinny Arsenal, Bldg. 1, 3rd Floor
Dover, NJ 07801-5001

Department of the Navy

Dr. Budd B. Adams 3
Head, Exploratory Development Group
NORDA, Code 113
Bldg. 1100, Room 258
NSTL, MS 39529-5004

Mr. Gary DuBro 1
Deputy Director for Studies Analysis, ONT
Boston Towers #1, Rm. 502
800 N. Quincy Street
Arlington, VA 22217-5000

Dr. Paul Kurtz 2
Head, R&T Department
Naval Coastal Systems Center
Bldg. 110, Rm. 232
Panama City, FL 32407-5000

V. Adm. P. F. McCarthy, Director 2
R&D Requirements, T&E
Rm. 5C686, The Pentagon
Washington, DC 20350

Mr. Hugh E. Montgomery 1
Deputy Director, Technology Assessment Div.
OP987B
Rm. 5D760, The Pentagon
Washington, DC 20301-3080

Mr. Robert Moore 5
Deputy Director, OCNR
Office of Naval Technology, ONT-20D
800 N. Quincy Street
Arlington, VA 22217-5000

Mr. Jerry Reed Assistant Commander, R&D Center Space and Naval Warfare Systems Washington, DC 20363-5100	1
Dr. Richard M. Root Assistant to Technical Director NORDA, Code 112 Bldg. 1005, Rm. A1 NSTL, MS 39529-5004	1
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Dr. Richard C. Sorenson Associate Technical Director Navy Personnel R&D Center, Bldg. 329 San Diego, CA 92152-6800	2
Mr. Glenn Spalding Director, Support Technology Directorate Office of Naval Technology, ONT-22, Rm. 507 800 N. Quincy Street Arlington, VA 22217-5000	1
Mr. Marshall J. Tino Associate Technical Director NSWC, Code D2, White Oak 10901 New Hampshire Avenue Silver Spring, MD 20903-5000	1
Dr. William M. Tolles Associate Director of Research for Strategic Planning Naval Research Lab, Code 1003 4555 Overlook Avenue Washington, DC 20375-5000	8

Dr. Daniel N. Viccione 3
Center Manager for Technology
Base Programs
Code 01V, Bldg. 101
Naval Underwater Systems Center
Newport, RI 02841

R. Adm. J. R. Wilson, Jr. 2
Chief of Naval Research
800 N. Quincy Street
Arlington, VA 22217-5000

Dr. Arno K. Witt 2
Technology Base Manager
Code 01B
Naval Air Development Center
Warminster, PA 18974

Dr. Elihu Zimet 1
Director, AAW/ASUW/SAT Directorate
Office of Naval Technology, BCT-1, Rm. 507
800 N. Quincy Street
Arlington, VA 22217

Department of the Air Force

Mr. James Burda 11
Chief, Plans and Programs Division
Air Force Armament Laboratory
AFATL/XP, Bldg. 13
Eglin AFB, FL 32542-5434

Mr. Donald L. Ciffone 2
Chief, Advanced Systems Research Office
Aviation Research & Technology Activity
Ames Research Center, MS 219-3
Moffett Field, CA 94035-1099

Dr. Gary L. Denman 1
Deputy Director, AF Wright Aeronautical Lab.
AFWAL/CD
Area B, Bldg. 45, Rm. 207
Wright-Patterson AFB, OH 45433

Dr. Fred Diamond 3
Chief Scientist
RADC/CA
Griffiss AFB
Rome, NY 13441

Mr. Michael Flynn Technical Advisor Directorate for S&T SAF/AQT Rm. 4D289, The Pentagon Washington, DC 20330-1000	1
Mr. Al Goldstain Director of Plans and Programs DCS/Technology & Plans, Rm. E302 HQ AFSC/XTX Andrews AFB, MD 20334-5000	2
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Dr. Keith Richey 1
Technical Director, AF Aeronautical Lab
AFWAL/CT
Area B, Bldg. 45, Rm. 214
Wright-Patterson AFB, OH 45433

Mr. Wilbert J. Uhl 1
Chief, AFWAL Plans Office
AFWAL/XR
Area B, Bldg. 45, Rm. 214
Wright-Patterson AFB, OH 45433

Dr. Billy Welch 1
Chief Scientist
Human Systems Div., HSD/CA
Bldg. 105, Rm. 216
Brooks AFB
San Antonio, TX 78235

Industrial Organizations

Mr. Brett Able 2
5805 Snowberry Court
Midland, MI 48640

Mr. Monroe Dickinson 2
Division Director of the Technology Staff
IBM Federal Systems Division, MS 410
6600 Rockledge Drive
Bethesda, MD 20817

Mr. Richard Hartke 42
Director of Technology Programs
Aerospace Industries Association
1250 I Street, NW
Washington, DC 20005

R. Adm. Leland S. Kollmorgen, USN (Ret.) 2
TLK, Inc.
1902 Joliette Court
Alexandria, VA 22307

Gen. Robert T. Marsh (USAF, Ret.) 5
6327 Manchester Way
Alexandria, VA 22304

Lt. Gen. Robert Moore (USA, Ret.) 2
Moore & Associates
1402 Monterrey Drive
Huntsville, AL 35081

Mr. Raymond Standahar 5904 Mt. Eagle Dr., Apt. 1106 Alexandria, VA 22303	2
Mr. Earl Wells Division Director of Strategic Planning IBM Federal Systems Div., Rm. 4202 6600 Rockledge Drive, MS 412 Bethesda, MD 20854	1
Mr. Doug R. Wilder Manager of Commercial Business Analysis IBM Federal Systems Div., Rm. 4A02 6600 Rockledge Drive, MS 412 Bethesda, MD 20854	1
Institute for Defense Analyses 1801 N. Beauregard Street Alexandria, VA 22311	
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